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ABSTRACTED

LYCOMING

DIVISION - THE AVIATION CORPORATION

WILLIAMSPORT, 38, PENNA.

INITIAL TEST OF THE MULTI REED VALVE
COMBUSTION CHAMBER
(section I Item 3 - Contract NOa(s)4718)

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LYCOMING
DIVISION--THE AVIATION CORPORATION

REPORT NO. 1097

~~RESTRICTED~~

Date of Test:

August 20, 1946 to February 7, 1947

Date of Report:

March 25, 1947

INITIAL TEST OF THE MULTI REED VALVE COMBUSTION CHAMBER
(Section I Item 3 - Contract NOa(s) 4718)

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NO. 60225 TRACING PAPER K. ELLIOTT CO. PITTSBURGH

LYCOMING
DIVISION--THE AVIATION CORPORATION

REPORT NO. 1097

INITIAL TEST OF THE MULTI REED VALVE COMBUSTION CHAMBER

I N D E X

NO. 8022S TRACING PAPER K. ELLIOTT CO. PITTSBURGH

INDEX - Con't

FORM 674 10M 4-48

LYCOMING
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REPORT NO. 1097

INDEX - Con't

NO. 6083 TRACING PAPS K. ELLIOTT CO. PITTSBURGH

INDEX - Con't

Page No.

Photostats:

NO. 50888 TRACING PAPA K. ELLIOTT CO. PITTSBURGH

INDEX - Con't

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APPENDIX-I

Log Sheets No. 1 through 121 from the Multi-Reed Valve Chamber Log Book attached to Experimental and Engineering Records Copies only.

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LYCOMING
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REPORT NO. 1097

[redacted]

INITIAL TEST OF THE MULTI REED VALVE COMBUSTION CHAMBER

OBJECT:

1. The object of this test was to obtain data from which the general performance characteristics of the Lycoming Multi Reed Valve Combustion Chamber could be evaluated.

SUMMARY

2. The subject combustion chamber was the second Lycoming design made to operate on the intermittent jet or "constant volume" cycle. This chamber differed from the first design (See Lycoming Engineering Report No. 1056) in that the inlet valves were of the automatic type, opened by ram pressure and closed by combustion pressures.

3. Operation of this unit was steadier than that of the Rotary Sleeve Valve Chamber, but cyclic combustion irregularities existed to such a degree that the task of obtaining reproducible data was a difficult one. Satisfactory operation was obtained at higher speeds (500 to 1200 cpm) and fuel flow range was increased at the higher speeds, but, at the conditions used during this test, ram pressure was limited to 25 psig. by failure to start firing at higher pressures. The decrease in airflow as fuel flow was increased at constant speed and ram pressure was much greater than was the case in the Rotary Sleeve Valve Chamber.

4. Exhaust gas analysis was attempted during the latter part of the test. Correlation of three methods of combustion chamber pressure measurement was attempted. Neither attempt was completely successful during the firing runs, but mean chamber pressure measurements were

an

successfully checked by using a steadily cycling air-operated test fixture in place of the chamber in which the cyclic pressures were quite irregular.

5. The test work covered by this report was done during the period from August 20, 1946 to February 7, 1947. Chamber operating time during this period totaled 67 hours 40 minutes. This time does not include calibrations or non-firing airflow tests.

CONCLUSIONS:

6. It is concluded that satisfactory operation, for the purpose of this test, was obtained, and that the data presented in this report is representative of the best operation obtained at the conditions of this test.

RECOMMENDATIONS:

7. The investigation of other variables, such as those listed in Lycoming Engineering Report No. 1056 (paragraph 8), not covered by this report is in order. A partial list is as follows:

a) Improvements in fuel atomization by higher fuel nozzle pressures, nozzle location, spray angle, supplementary heaters, and/or deflectors.

b) Location and type of points of ignition

c) Size and shape of jet nozzle

d) Size shape and location of the supply air valves

e) Different types of fuel

DESCRIPTION:

8. The multi reed valve combustion chamber used for this test was assembled as shown in the exploded view of photograph No. E-4495, page 77.

9. The principal parts making up the unit were assembled in the

NO. 6025 TRACING PAPER K. ELLIOTT CO. PITTSBURGH.

FORM 674 10M 4-48

following manner. The 18 reed valves, part No. 70760, were supported between two concentric cylinders, each of which contained 18 ports. The valves seated on the ports in the external cylinder, part No. 70761, and were held in position when off the seats by the inner cylinder, part No. 70825, and two end spacing rings, part No. 70754. The head of the chamber was formed by the closed end of the inner cylinder or valve stop plate assembly, part No. 70825. The ports were covered on the outside by a full circular manifold, part No. 70751. To the rear of the above described portion was bolted a barrel section, part No. 70748, containing locations for 8 spark plugs. The 1.06" convergent nozzle, part No. 70714, was bolted to the rear end of the barrel assembly. Inside combustion chamber dimensions were 5" diameter by 22 1/4" length. The combustion chamber was fully jacketed, including the valve stop plate cylinder and was liquid cooled. Two more plug locations for special long reach type spark plugs, (Champion F-5A), were provided for in the head end of part No. 70825, one on either side of the adjustable reach fuel nozzle location, which was in the center of the head.

10. The ignition system used during this test was similar to that described in Lycoming Engineering Report No. 1056 for the timed ignition runs. For this test, however, the interrupter was by-passed and continuous ignition at the rate of several hundred sparks a second throughout the cycle was used for the entire test. Four points of ignition were used in the chamber. Two Champion F-5A special long reach plugs were used in the head end location, and two modified DL-8C Champion plugs were used in the two top locations directly behind the manifold. See Photo No. E-4544, page 82, showing DL-8C plugs modified to give 5/8" extension into chamber. Standard DL-8C plugs

NO. 6022S TRACING PAP. K. ELLIOTT CO. PITTSBURGH

extend only 3/8" into the chamber.

11. With the exception of the 70802 assembly, the fuel system is identical with that described in Lycoming Engineering Report No. 1056. A 60 degree spray Bosch nozzle was used in the 70802 adjustable reach injector assembly. The end of the nozzle was left fixed at 1 1/4" extension inside the chamber throughout this test.

12. Two normally open Fisher, type 4300, automatic regulating valves were used to replace those used during the rotary valve unit test. Otherwise the combustion air system was identical to that described in Report No. 1056.

13. The test stand and instrumentation were those designed for former tests and, with the following exceptions, are described in Report No. 1056.

a) Thrust cylinder relocation

During this test, while trying to eliminate small errors in the thrust measuring system, it was thought advisable to change the location of the thrust cylinder. The large subframe, which rode on rollers and carried the parallelogram on which the engine was mounted, was bolted solidly to the floor. The thrust cylinder element was uncoupled from the front of the subframe and set up on the apex of the solid "A" frame with the plunger attached to the top member of the parallelogram. In this way, the thrust cylinder took the chamber reaction through only the top member of the parallelogram instead of the subframe, which, in addition to its own mass, carried the weight of the pumps,

NO. 6028S TRACING PAP. K. ELLIOTT CO. PITTSBURGH

motor, and gear box.

b) Ram air elbow

The former straight vertical ram air hose was removed and was replaced by the 90 degree elbow to increase flexibility and to eliminate vertical load on the parallelogram due to ram air pressures.

c) Pressure-time indicator

An M.I.T. balanced diaphragm type pressure-time indicator was obtained for a part of this test to give permanent records of cyclic pressures. The drum of the indicator was driven through an extension shaft off the rear of the same motor used to drive the fuel pumps. The balanced diaphragm element was installed in one of the rear spark plug locations.

d) Exhaust gas samples

Gas samples were obtained through a straight total pressure type probe located 2" behind the jet nozzle throat in the center of the jet. An Orsat gas analyzer was used to determine the proportions of CO_2, O_2, and CO in the exhaust gas sample.

e) Cylinder pressure gauge

An indicating mean chamber pressure instrument in the form of a Bourdon tube gauge and orifice arrangement was used in addition to the M.I.T. indicator and the Trimount pick-ups to show relative mean pressures. The pressure tap for this gauge was a .063" orifice in one of the rear spark plug locations, diametrically opposite the M.I.T. balanced

NO. 5022S TRACING PAP. K. ELLIOTT CO. PITTSBURGH

diaphragm element. This sampling tap was connected by a short run of 5/16" copper tubing to an expansion chamber of approximately 12 cubic inches volume. A 1/8" needle valve on the outlet of the expansion chamber was used to further damp out pressure surges to the gauge which was connected to the expansion chamber by approximately 25' of 5/16" copper tubing.

f) Electronic thrust

The electronic thrust meter was removed after some of the preliminary checks of this test had been made. It was omitted from the instrumentation for the remainder of the test and thrust was measured solely by the hydraulic system.

METHOD OF TEST:

14. The reed valve chamber was operated to check the revised ram air control system, reproducibility on firing and non-firing operation, and thrust stand changes for a large proportion of the time up to 23.5 hours total operation. Some data had been taken at the conditions shown in the following schedule, but all runs made prior to this time were repeated.

15. This test was made at the following conditions and in the following manner.

CONDITIONS

Spark plugs

2 F-5A Champion long reach plugs - in head locations

2 DL-8C Champion plugs modified to have .63" reach into

NO. 6025 TRACING PAPE. ELLIOTT CO. PITTSBURGH

chamber - in top locations behind manifold. (See Photo No. E-4544, page 82.)

Continuous spark - battery and Ford spark coils

Fuel spray nozzle - adjustable reach 70802 assembly set at 1 1/4" extension into chamber with an EGN-6382 Bosch nozzle.

Fuel injection pumps - two EJN-7648 Bosch pumps coupled in parallel and synchronized.

Reed valves - Flat reeds, part No. 70760.

Jet nozzle - Part No. 70714 (Actual throat diam. 1.060")

OPERATION

A. Reproducibility runs were made at the following conditions.

15 psi ram air pressure

500 to 900 ipm by 100 ipm increments

At least four fuel flow settings at each ram and speed

Three complete sets of runs were made on successive days.

B. Non-firing airflow and thrust vs ram pressure checks from 15 to 35 to 15 psi ram pressure in 5 psi increments were made on three successive days and at intervals during the remainder of the test.

C. Runs were made at 5 psi and 100 ipm intervals starting at 15 psi and 500 ipm as follows:

1. The range of fuel flow which would give steady operation at 15 psi ram and 500 ipm cyclic speed was determined. This fuel flow range was then divided to get 5 readings.

NO. 8025 TRACING PAPER K. ELLIOTT CO. PITTSBURGH

2. The speed was then increased in 100 rpm increments repeating part C (1) above until unsteady firing or a decrease in thrust was found.

3. The ram air pressure was increased 5 psi and parts C (1) and (2) were repeated as above.

4. Ram pressure was increased in 5 psi increments until 30 psi ram was reached, at which point the scheduled runs were terminated.

D. A non-firing run was made at the start of each ram air pressure change to check airflow and thrust.

E. A reverse flow reed leak test was made at the end of each series of runs or at the end of days runs. Ignition was also checked at these stops.

16. During the above scheduled operation, the following changes were made.

(a) Fisher automatic ram air pressure regulating valves were installed for use after 18 hours of total engine operation.

(b) The straight vertical ram air connecting hose was removed and replaced by a 90 degree elbow with flexible hoses in each leg.

(c) First the strain gauge thrust link for electronic thrust measurement was replaced, and then electronic thrust measurement attempts were abandoned altogether.

(d) The heavy test stand subframe was lowered from its former suspended position and was anchored solidly to

NO. 8022S TRACING PAPER K. ELLIOTT CO. PITTSBURGH

the floor. The hydraulic piston type thrust reaction element was moved from the subframe mounting and was installed on top of the "A" frame to take the thrust reaction of the chamber through the top member only of the parallelogram. (See drawing No. 70713, page No. 101 of Lycoming Engineering Report No. 1056).

17. During this preliminary test, the engine was disassembled for inspection three times. The first two inspections were made in spite of the fact that no trouble was indicated either in operation or leak tests. These inspections were made after 1 hour 4 minutes and 31 hours 44 minutes total chamber operation respectively. After 40 hours total operation, however, the reverse flow reed leak test indicated excessive leakage back through the reeds and the unit was again removed for inspection.

18. The test schedule was continued and was completed through the 25 psi ram pressure portion of the schedule, at which point it was decided to terminate running on this schedule.

19. At this point, the effect of ram pressure alone on thrust was investigated. This was accomplished by plugging the jet nozzle and applying ram air pressure to the system, while readings of thrust, cylinder pressure, and ram pressure with zero airflow were taken.

20. Checks of a thrust system having a diaphragm type hydraulic element, in place of the piston type used throughout this test, were made.

21. A reproducibility check was made at what had been determined as the best operating conditions for the chamber, as found during the earlier

NO. 5025 TRACING PAPE. A. ELLIOTT CO. PITTSBURGH.

FORM 674 12M 4 45

part of this test. These runs were made therefore at 900 cpm cyclic speed and 20 psi ram air pressure. Along with the reproducibility of thrust, airflow, and fuel flow operating range, mean chamber pressure measuring methods were checked. Pressures were measured by means of two Trimount pick-ups, (one 100 psi, and one 300 psi range unit), an M.I.T. balanced diaphragm type recording indicator, and a Bourdon tube gauge, damped so as to read relative mean pressures.

22. Pressure measuring methods were again checked. This time, however, an air-operated test fixture was used in place of the chamber to produce the intermittent cyclic pressure pattern.

23. The chamber was disassembled for inspection and to have photographs made of the parts at the end of the test, after 67 hours, 40 minutes of total operation.

24. Throughout the test, the thrust and dynamic pressure pick-ups were calibrated each day before operating. Thrust and ram air pressure gauges were calibrated once during this test. Other gauges and meters used for this test had been calibrated prior to this test. (See Lycoming Engineering Report No. 963).

25. Aviation 73 octane fuel conforming to specification ANF-23 was used throughout this test.

26. The subject test covered the period from August 20, 1946 to February 7, 1947. Operating time accumulated during the test was 67 hours, 40 minutes. This time does not include the periods spent in non-firing airflow checks and calibrations.

RESULTS:

27. The operation of the chamber during this test indicated that,

NO. 6025 TRACING PAPER K. ELLIOTT CO. PITTSBURGH

although firing was considerably steadier over a wider range of conditions than was experienced with the rotary valve chamber, (See Report No. 1056), cycle to cycle combustion pressures were still very irregular. This is shown graphically on the pressure-time diagrams, pages 83 through 128 . That the traces were irregular on both the pressure and time bases was observed on the oscilloscope trace of the electronic pressure instrument. See Photographs on pages 132 to 135.

28. The results of the chamber performance portion of this test are shown on curve sheets No. 7412 through 7453, pages 22 through 63 . The data was plotted in two forms to show variations not only versus speed, but also versus ram pressure. It will be noted that, while the curves of constant ram pressure are quite evenly spaced, the curves of constant speed, curve sheets No. 7436, 7437 and 7438, pages 46, 47 and 48 show that the higher speeds are grouped at the top of the thrust vs fuel flow plots, indicating that the unit had an optimum speed somewhere in the range from 800 to 1200 cpm.

29. Curves No. 7439, 7440 and 7441, pages 49 , 50 and 51 show that airflow is dependent on, and varies with, fuel flow and cyclic speed regardless of ram pressure.

30. The non-firing airflow vs ram pressure curve, sheet No. 7449, page 59 , shows that above two atmospheres ram pressure, the relation is substantially a straight line. The non-firing thrust vs airflow plot, curve sheet No. 7448, page No. 58 , indicates a similar relation, in that above the airflow obtained at two atmospheres ram pressure, the relation is linear.

31. Plots of the reproducibility checks, curve sheets No. 7445,

NO. 0325 TRACING PAPR K. ELLIOTT CO. PITTSBURGH

7446, and 7447, pages 56 and 57, show maximum variations of thrust and airflow in the order of 2-1/2 and 2% respectively, which are measures of some of the best agreement found during this test for data from firing operation.

32. Summary data sheets, pages 66 through 76, contain the data from all runs selected for presentation in this report.

33. Curve sheet No. 7454, page 64, shows a factor for which correction was not made on the aforementioned plots. This thrust variation, although numerically small, is an overall correction which should be applied negatively to all of the above curves in any analysis, since it is appreciable in some cases on a percentage basis.

34. The results of instrument checks made at the end of this test are shown on curve sheets No. 7450, 7451, 7452 and 7453, pages 60, 61, 62 and 63, and table No. 1, page 65. These curves show the comparison of four measurements of the mean chamber pressures taken during the reproducibility checks at 900 cpm and 20 psi ram. The M.I.T. indicator diagrams were so spread for these firing runs, due to the cyclic pressure variations, as stated before, that only an approximate value of mean pressure could be obtained. However, the mean pressures that were plotted indicated that the M.I.T. mean pressures check those measured by means of the 100 psi range Trimount pick-up. The four mean pressure measuring instruments were checked again, this time on an intermittent air pressure test fixture made to give a cyclic pressure diagram similar to that of the chamber firing diagram. Results of these checks are shown in tabular form on page 65. Fine line traces were obtained from the M.I.T. indicator on the air test fixture because of its steady cyclic

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pressure pattern. (See Photographs pages 129 through 131). The M.I.T. results were therefore taken as the standard and the results of the Trimount pick-ups and gauge were compared to it.

35. Only once during the entire test was the test interrupted by trouble from component parts of the chamber. The third disassembly inspection was made to determine the cause of excessive reed valve leakage under reverse flow reed leak test. One reed was found to have taken a permanent set and was arched 3/64" off the seat. At the other inspections several reeds had been found to be arched away from the seat, but not to the extent that the low pressure used during the reverse flow reed leak test would not return them to their seats.

36. The condition of parts at the end of the test is shown in Photos No. E-4495 through E-4499, pages 77 through 81. Photo No. E-4498 shows the seat side of the reeds and Photo No. E-4499 shows the opposite side. When removed, the reeds had a carbon coating which made identification by number almost impossible, and the numbers shown in the photographs were found to be in error. The following key will properly identify the reeds by number and position in the two photographs.

First Row	Second Row
1	3
2	10
17	11
4	12
5	13
6	14
9	15
8	16
18	7

NO. 6022S TRACING PAPS ... ELLIOTT CO. PITTSBURGH

37. Copies of all M.I.T. indicator diagrams on which a complete trace of the cycle was obtained are shown on pages 83 through 131 of this report. Pages 83 through 128 showing diagrams taken during the reproducibility checks at 900 cpm, and 20 psig ram, clearly illustrate the cyclic irregularities described above. Pages 129 through 131 show the contrasting steadiness of the traces taken during the air test fixture runs for comparison of pressure measurements.

38. Photographs of the oscilloscope traces taken during the reproducibility runs are shown on pages 132 through 135 . These records, especially Photographs on pages 132 & 133, show the cyclic pressure and time shifts plainly. Due to an undetermined source of trouble in the camera, other photographic records of this part of the test were found to have recorded only parts of the cycle. Pages No.136 and 137 show two photographs taken during the air test fixture checks. Photo (a), page 136, taken at 0.2 sec. exposure time, of a run made at 507 cpm shows approximately 1.7 cycles. Photo (b), page 137 taken at 0.1 sec. exposure time of a run made at 1089 cpm, shows approximately 1.8 cycles. Differences in the cyclic steadiness are easily apparent from a comparison of these two groups of photographs.

DISCUSSION:

39. The operating range of the chamber, for the conditions used for this test, was apparently limited to speeds of from 500 to 1200 cpm, and in ram pressure from 15 to 25 psig. Above 1200 cpm firing was uneven and the fuel flow range was quite narrow. At the lean limit of fuel flow, missing and malfiring made stable readings impossible, but at the rich end, the condition termed "constant burning" was en-

NO. 60233 TRACING PAPS. ELLIOTT CO. PITTSBURGH

FORM 874 13M 4 46

countered. This condition can possibly be better described as "torching". The change from regular cycling to torching was quite abrupt and airflow and thrust, as well as mean chamber pressure, dropped immediately as fuel flow was increased through the limit. Once torching had been started, it was necessary to reduce the fuel flow 10 to 15% below the point at which torching had started to obtain regular cycling again. After this condition had been encountered, a reading was taken at the rich end of each curve in the torching condition, not to evaluate the performance at this condition, but to indicate the rich limit of operatable regular cycling. Above 25 psi ram pressure, firing could not be started in the chamber with operating conditions as used throughout the rest of the test. It was found, however, that the spark plugs used in the head end of the chamber had little or no effect, but that, if plugs were installed in the two top locations of the rear plug belt in the barrel, the chamber would start to fire at any ram pressure up to and including 35 psi. This, however, was merely a check point, and no more running with changed spark plug positions was done during the remainder of the test.

40. Although the oscilloscope trace of the pressure pattern of this chamber had indicated that cyclic pressure variations existed, the effect on the thrust and airflow data could not be discerned. It was not until diagrams from the M.I.T. indicator were obtained that the amount of the pressure and time change from cycle to cycle was realized. With the amount of cyclic variation observed even during the reproducibility checks at 900 cpm and 20 psi ram it is surprising that the data obtained showed signs of correlation at all. During future investigations the amount and frequency of the irregularities, as shown by these

NO. 60535 TRACING PAPR. K. ELLIOTT CO. PITTSBURGH

two instruments, might well be used as a measure of the increase in quality of combustion, or more aptly, the steadiness of combustion.

41. Since this was not an endurance test, several reeds were replaced at each inspection, not because of failure or malfunctioning, but to insure having the best operating conditions obtainable. Three reeds were replaced at the first inspection, because they were found to be slightly kinked across the seating surface. It is entirely possible that these reeds were kinked when originally installed, but no effect on operation was discernible. Five reeds were replaced at the second inspection. Three of these showed a tendency to arch away from the seat, and one showed the trace of a mark across the seat surface, but no blowby was indicated. The fifth reed was replaced only because it had an arch toward the seat of such an amount that installation was made difficult when the unit was assembled. At the same inspection, five reeds were installed in reversed position, (end for end), because marks on the reeds indicated that the seat on one edge was quite narrow. At the third inspection, five reeds were replaced because of minor distortions. One of them was replaced by a reed of the same number which had been removed at a previous inspection. The number 10 reed, which was the cause of the inspection, was reinstalled in inverted position (arch to the seat). At the inspection made at the end of the test, no parts were replaced.

42. The test stand was altered several times to eliminate small sources of error which had not been significant when the MX-544 unit was being tested. The following factors were discovered and eliminated during the course of the test:

NO. 50215 TRACING PAPER. K. ELLIOTT CO. PITTSBURGH

(a) The Lord rubber bushings in the top member of the parallelogram were replaced by brass bushings and steel pins in an attempt to raise the resonant frequency of the stand to eliminate disruption of the thrust pattern from the electronic thrust system.

(b) The electronic thrust equipment was abandoned because it was found impractical to alter the stand to get thrust diagrams which could be accurately averaged to indicate the mean thrust.

(c) The straight vertical ram air connecting hose from the ram air piping to the manifold was removed and a 90 degree ell with both legs flexible was installed. This change was made to eliminate the vertical load applied to the stand by the ram air pressure in the straight 4" hose.

(d) The heavy subframe was lowered from its partly suspended position and was solidly bolted to the floor. The hydraulic thrust cylinder was then moved to the top of the "A" frame. In this way the mass of the subframe, motor, gear box, injector pumps, and "A" frame was removed from the active part of the stand as far as the thrust measurements were concerned. (See drawing No. 70713, page 101 of Report No. 1056). The thrust cylinder then took the chamber thrust reaction through the top member only of the parallelogram.

(e) The vertical legs of the parallelogram were found to slant approximately 3/16" forward of the neutral position at rest. Static vertical loads were found to have a small but measurable positive effect on thrust. This error was corrected by bringing the parallelogram legs to a vertical position.

(f) At low speeds (500 to 700 ipm) the ram air piping was found to respond to the cyclic thrust impulses, vibrating enough to cause thrust meter indications to fluctuate objectionably. Bracing was installed to stiffen the lower end of the ram air piping to reduce the vibration.

(g) Although calibrations with and without the ram air hose connected showed very small errors, a measurable effect was found when ram air pressure was applied to the ram air hose. This effect was measured statically at zero airflow conditions - jet nozzle plugged. Since no means of eliminating this error could be found, a correction curve was included in this report so that the effect on the data could be evaluated.

(h) A diaphragm type thrust element was installed in place of the piston type, and was checked by static calibration and under firing conditions for stability and reproducibility. While fluctuations under firing conditions were small and response was rapid, zero shift and changes under static calibration conditions were much greater than with the piston type.

43. The electronic mean pressure and thrust measuring equipment was

NO. 6055 TRACING PAPER. K. ELLIOTT CO. PITTSBURGH

revised several times during this test. Good agreement between this method and others was never attained on the thrust system, and electronic measurement of thrust was finally abandoned, because changes in the stand necessary to the good performance of this system were not practicable. The pressure measuring part of the system was retained, and after revisions to eliminate objectionable drift and instability, finally showed very good correlation during the checks made with the air test fixture, (see table 1, page 65). This was, perhaps, the only fair dynamic test to which this instrument was subjected. It is almost too much to expect that three instruments, as widely different in principles of construction and operation as those used during this test, would measure and mean the erratically changing cyclic pressures of the firing operation of this chamber within the limits desired for good reproducibility. After the last revision to the electronic equipment, it was quite possible to get relative measures of the pressure changes caused by changes in the operating conditions from all three instruments, but to get close agreement among the absolute pressure values was difficult and time consuming.

44. Considerable difficulty was had with both the balanced diaphragm contactor and the timing circuit of the M.I.T. indicator. The instrument was found to have been received in a damaged condition, so that it was necessary to replace the pointer cylinder head plug before the instrument could be operated. The cylinder contactor units, as received, were not in good operating condition. The clearance between the diaphragm and the insulated contact pin was very critical for good operation. While theoretically this setting can be made so that only 2" of water

NO. 6023 TRACING PAPA. A. ELLIOTT CO. PITTSBURGH

pressure is required to move the diaphragm into contact, it was found, during this test, that 1/2 to 2 1/2 psi was actually required. During the comparisons made on the air test fixture, it was found that 2.6 psi was required to cause the diaphragm to contact, and a correction of this amount was applied to the values measured by the M.I.T. indicator. The timing of the spark trace of the indicator is done by an electronic circuit, which also gave trouble. When the first attempts to use the indicator were made, the circuit would function on only half of the trace. The circuit was checked twice and finally partly replaced before complete traces could be taken consistently.

45. The 70714 jet nozzle, as delivered to the Aeropulse Laboratory, was very rough in the nozzle bore. It was found necessary to take a finishing cut out of the converging section to clean it up. The finished diameter, when checked just prior to installation, was 1.060" rather than the 1.00" specified on the 70714 drawing.

46. The EGN-6382 Bosch fuel nozzle, serial No. 2, which was used to replace the damaged nozzle (serial No. 1) of the same type, had a poor spray pattern. This was the only similar nozzle obtainable, and was used because of necessity rather than choice, since, although differences in the data could not be detected, it is possible that the faulty spray may have contributed to the erratic nature of the cyclic pressure diagram. The same may be said for the metering of the EJN-7648 injection pumps. Checks made during the rotary valve chamber test and during the subject test, show more variation than was desired in readings taken at various speeds with the metering control locked.

47. Exhaust gas analyses made by means of the Orsat apparatus are not shown among the data of this test. In addition to the fact that

NO. 60255 TRACING PAPER. ELLIOTT CO. PITTSBURGH

results of the first samples were placed in doubt because of faulty technique in operating the apparatus, the possibility of the inclusion of unburned charge in the sample actually precludes use of this type of apparatus altogether. There is also some doubt as to whether the method used during this test to obtain gas samples yields a truly representative sample of the products of combustion.

NO. 6055 TRACING PAPE. . ELLIOTT CO. PITTSBURGH

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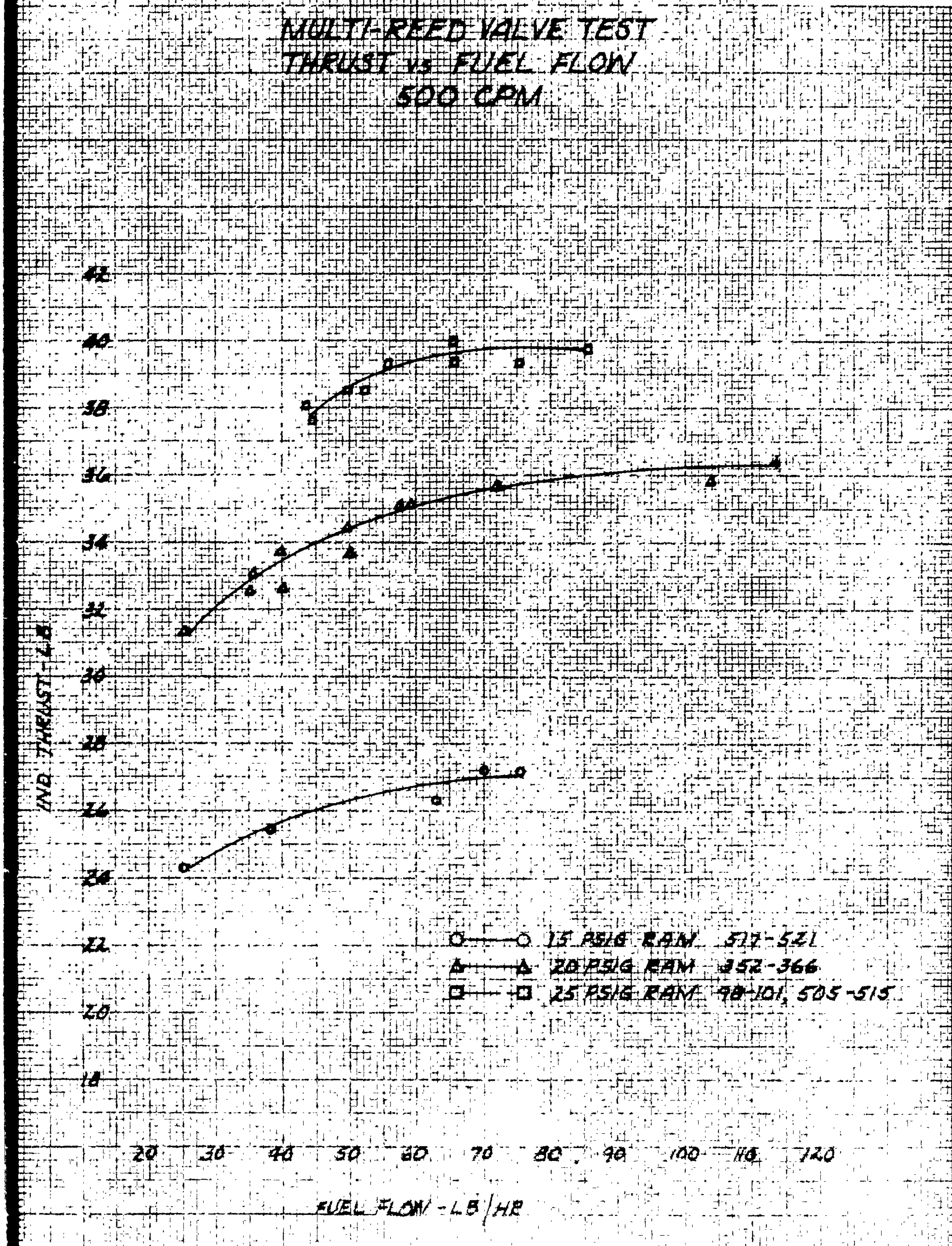
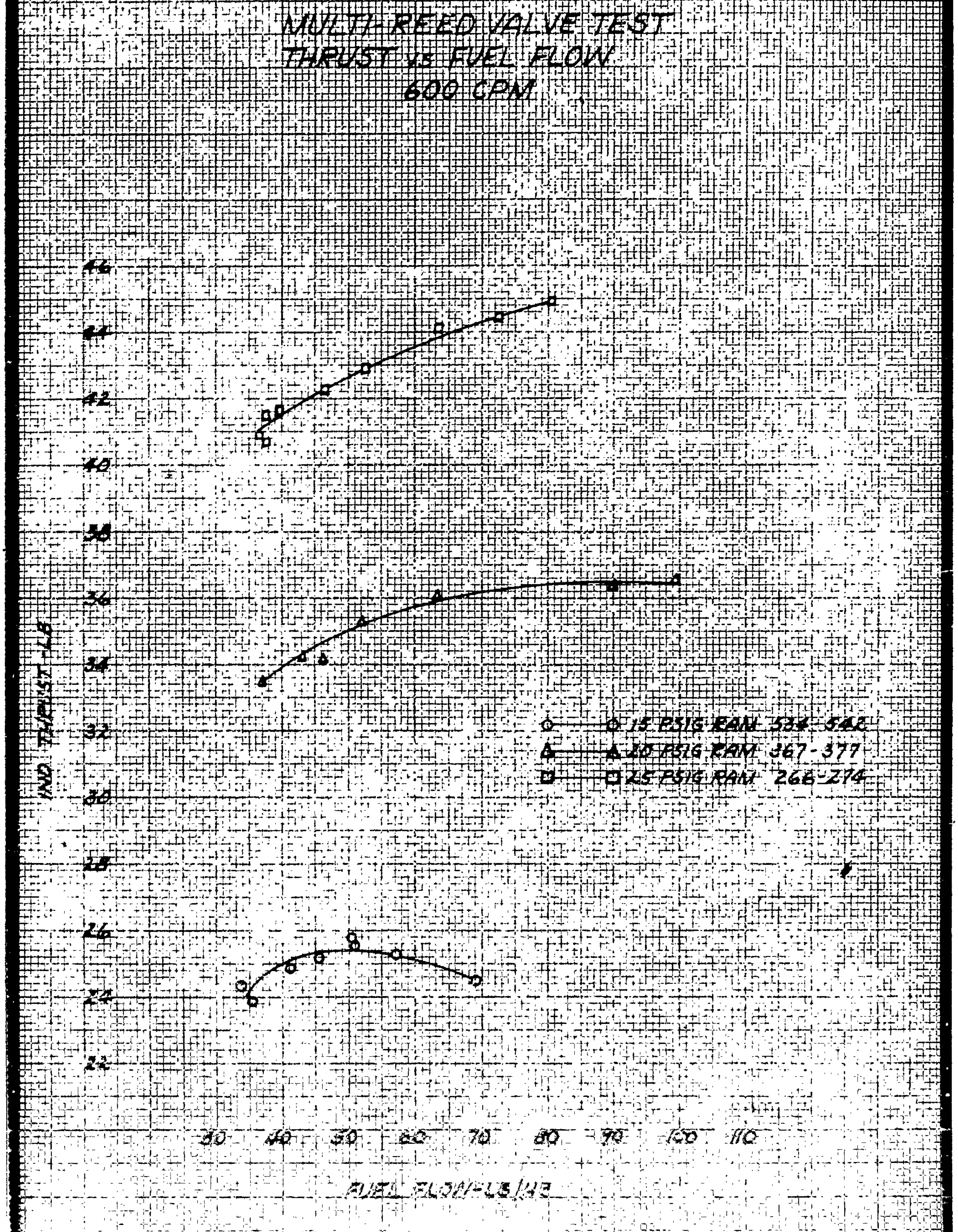
REPORT NO. 1097
CURVE NO. 7412



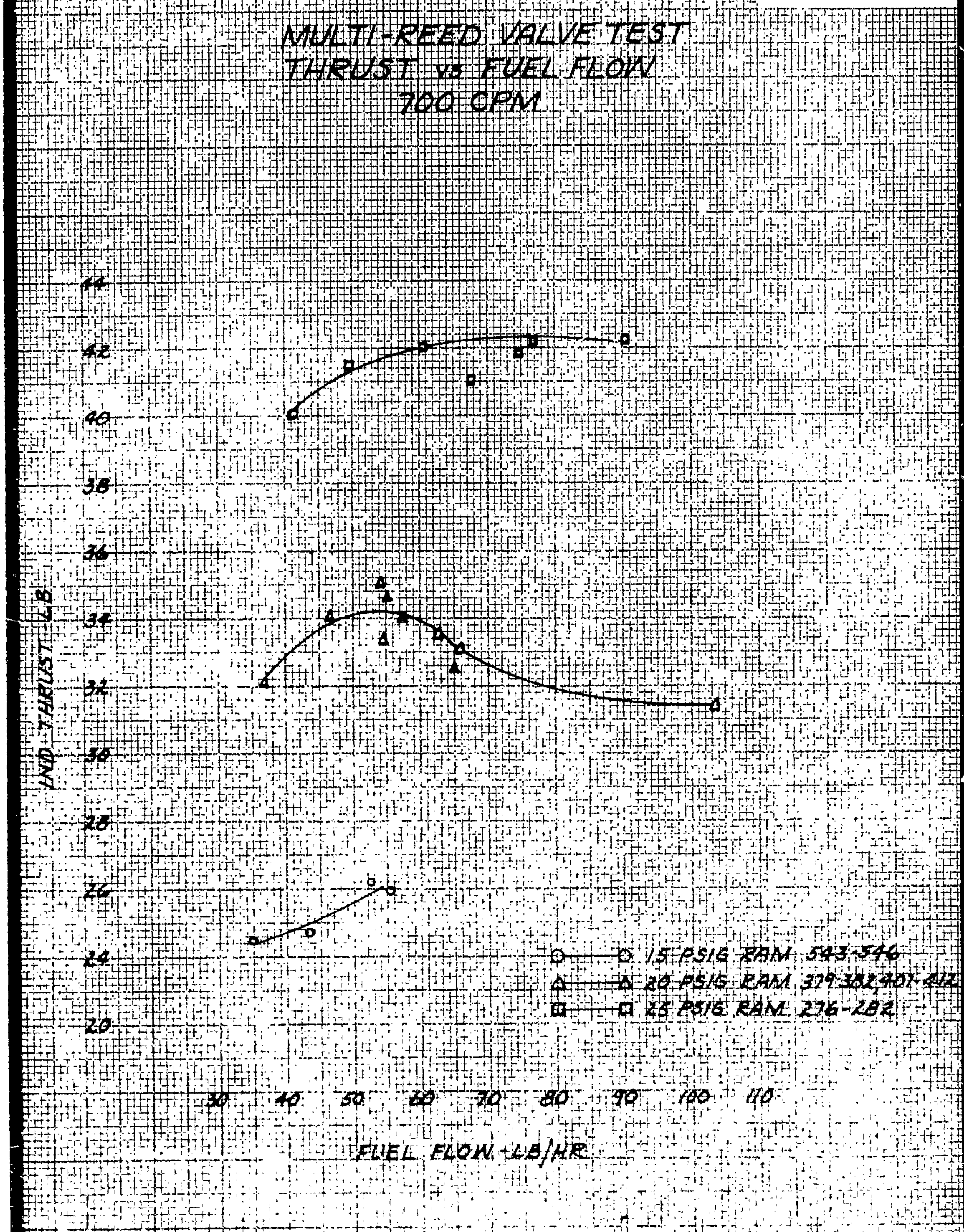
LYCOMING
Division - The Aviation Corporation

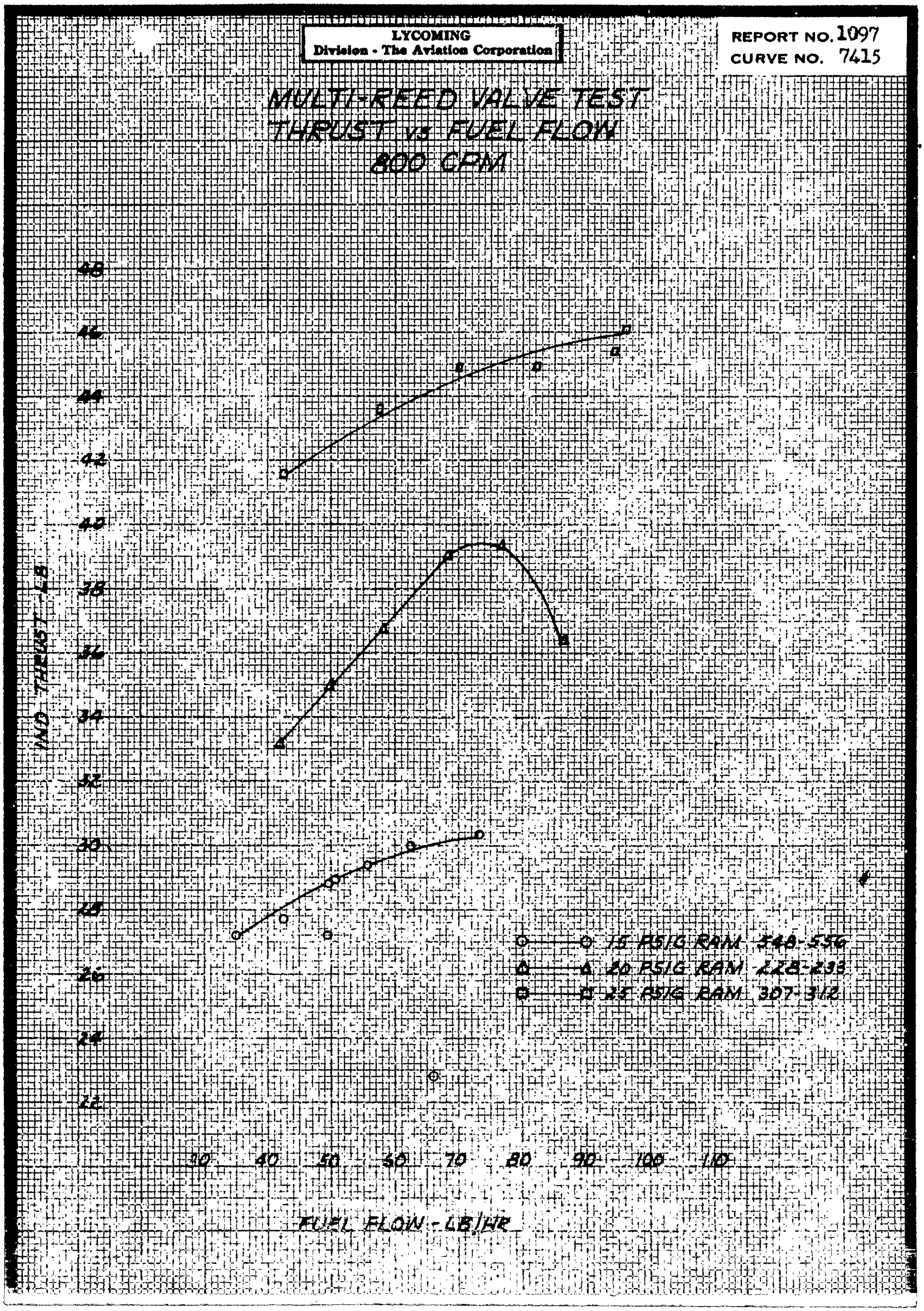
REPORT NO. 1097
CURVE NO. 7413



LYCOMING
Division - The Aviation Corporation

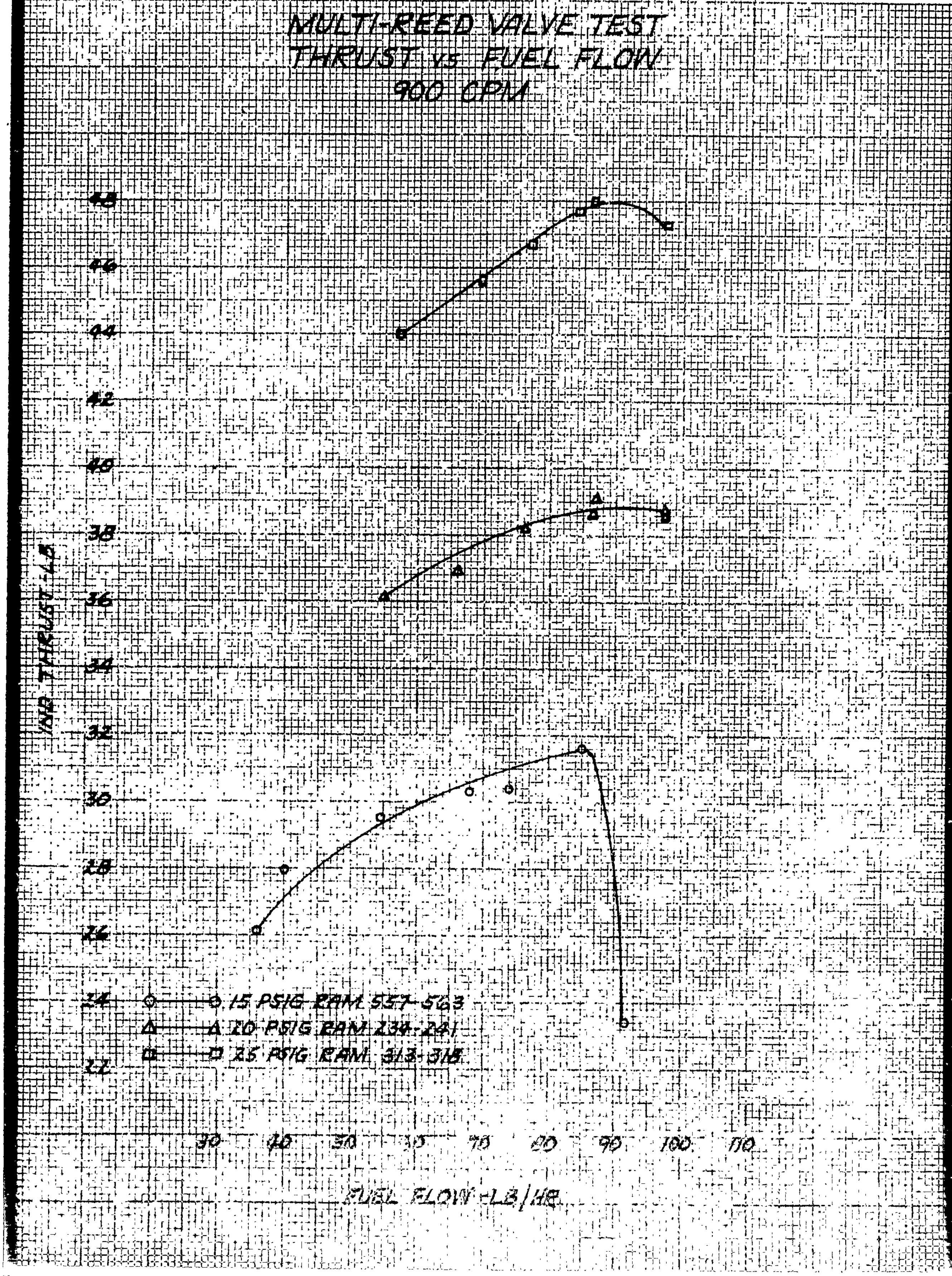
REPORT NO. 1097
CURVE NO. 7414

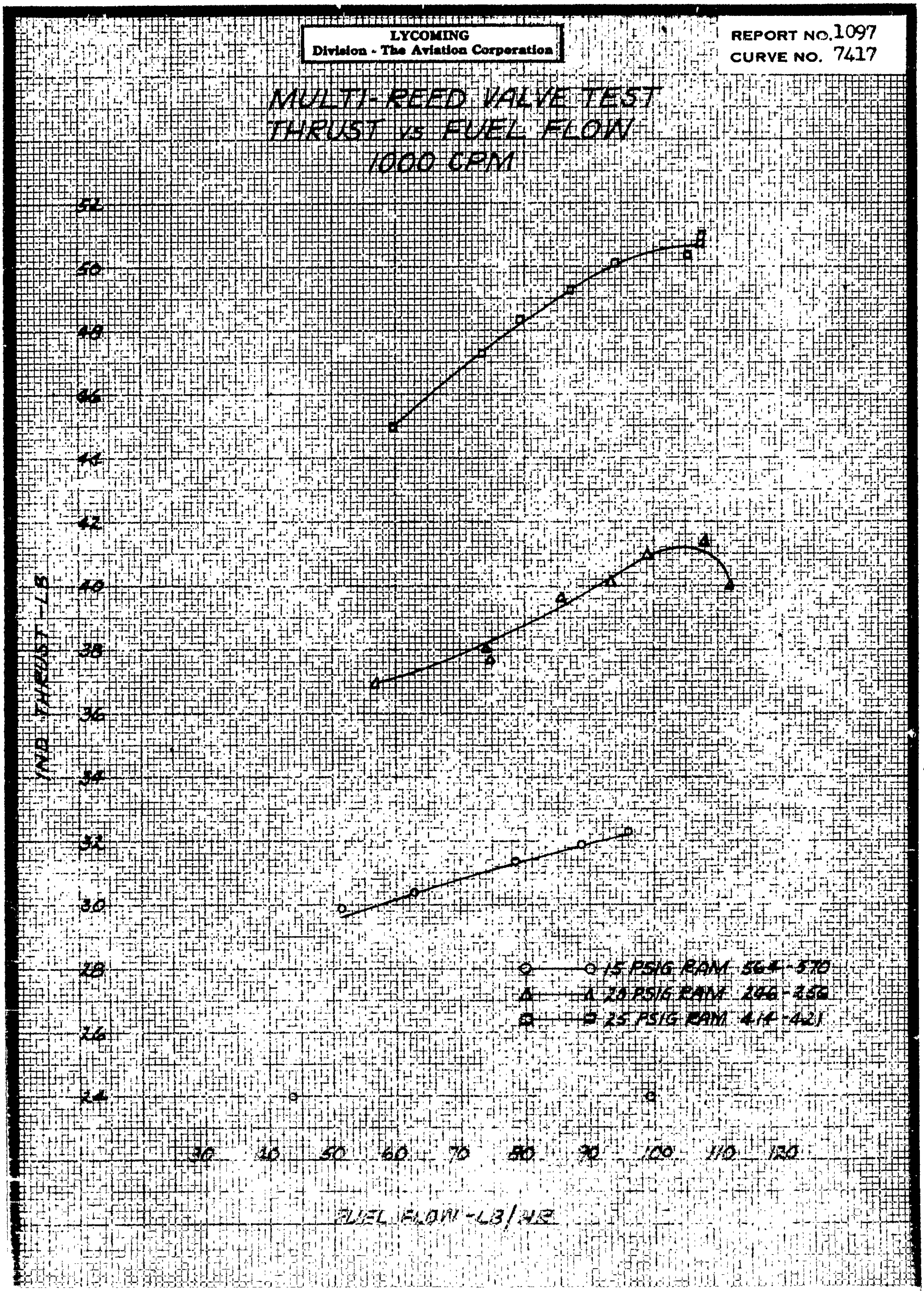


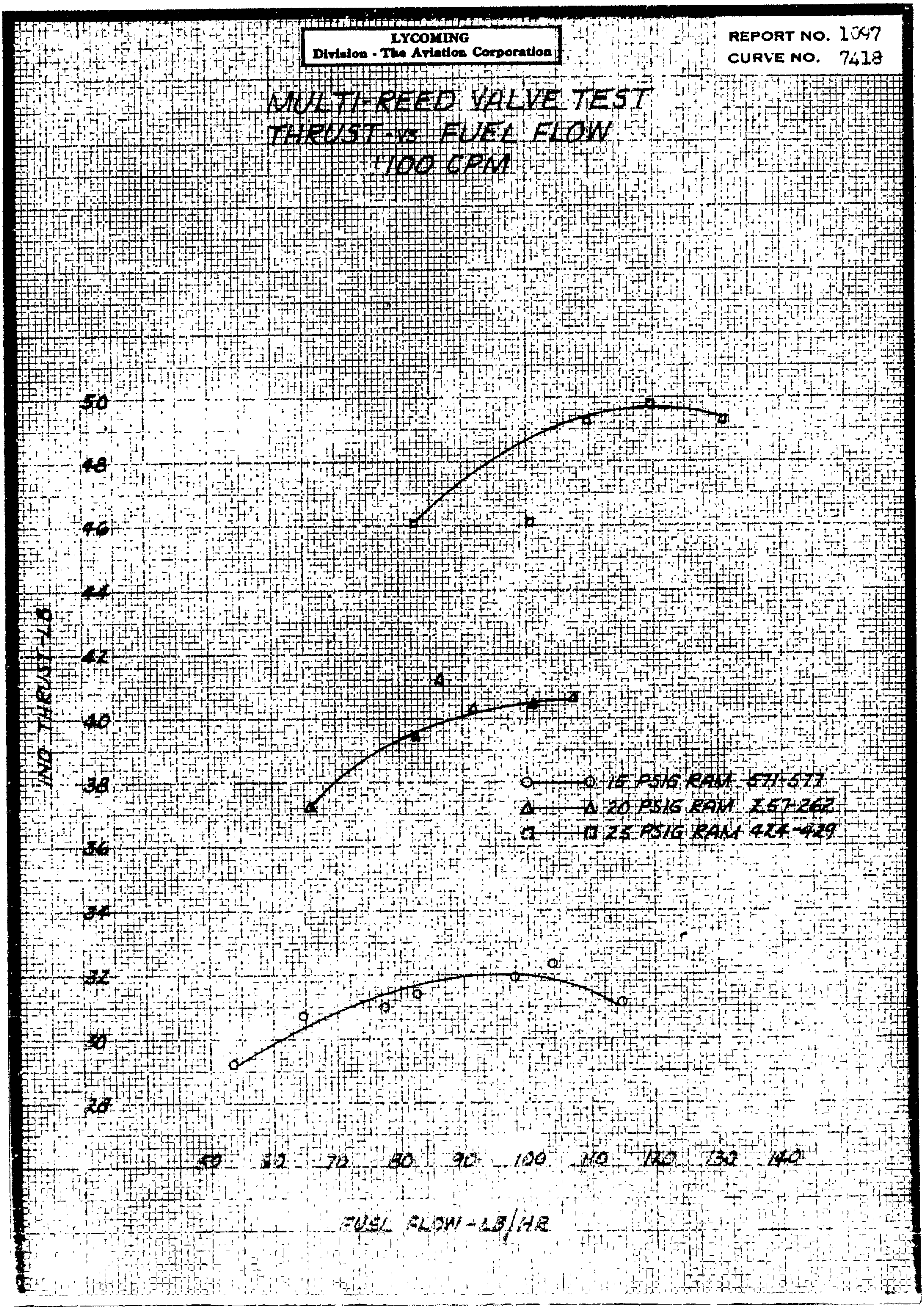

LYCOMING
Division - The Aviation Corporation
REPORT NO. 1097
CURVE NO. 7415
MULTI-REED VALVE TEST
THRUST vs FUEL FLOW
800 CPM
IND THRUST - LB
48
46
44
42
40
38
36
34
32
30
28
26
24
22
30
40
50
60
70
80
90
100
110
FUEL FLOW - LB/HR
15 PSIG RAM 548-556
20 PSIG RAM 228-233
25 PSIG RAM 307-312

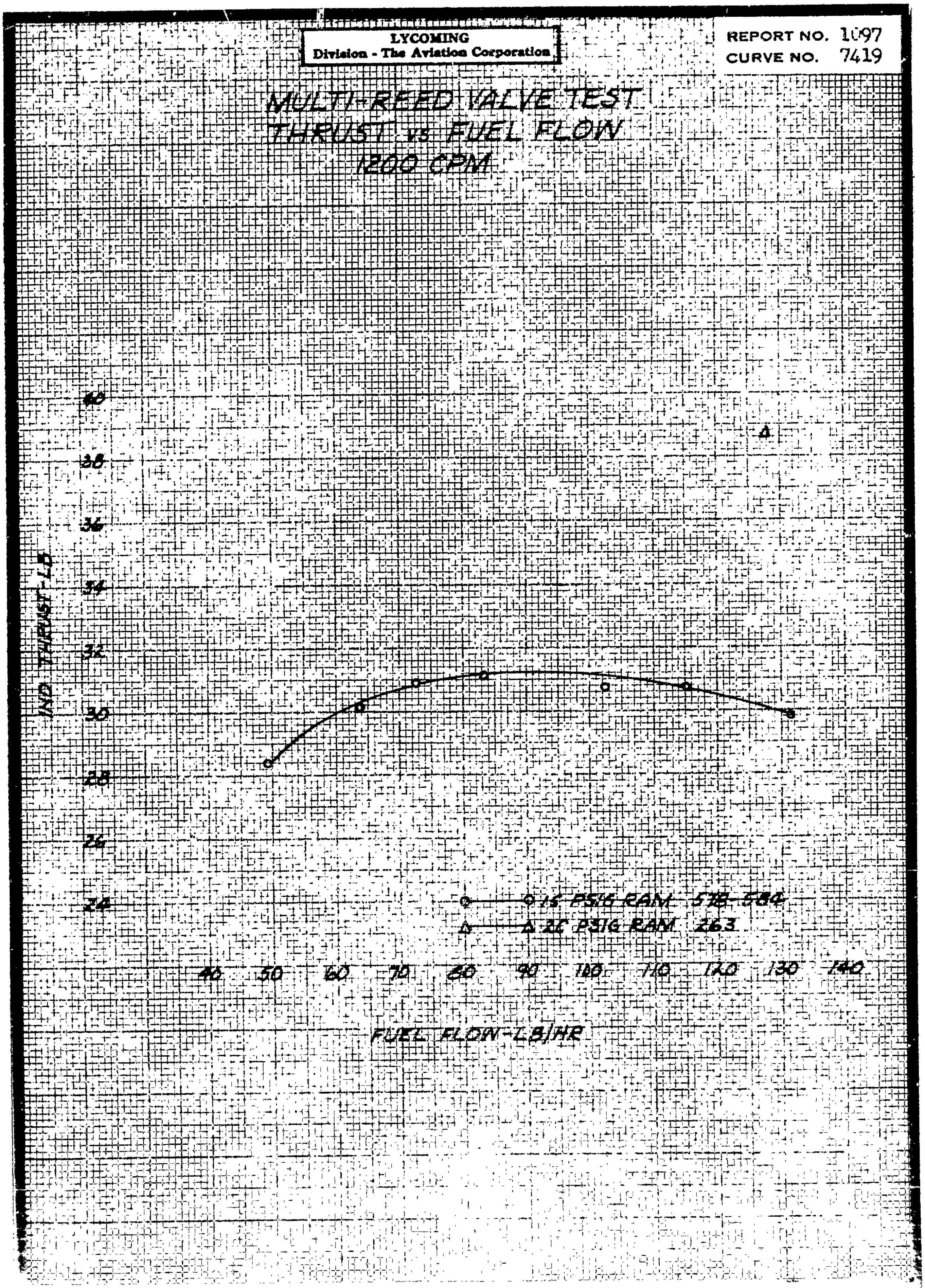
LYCOMING
Division - The Aviation Corporation

REPORT NO. 1097
CURVE NO. 7416



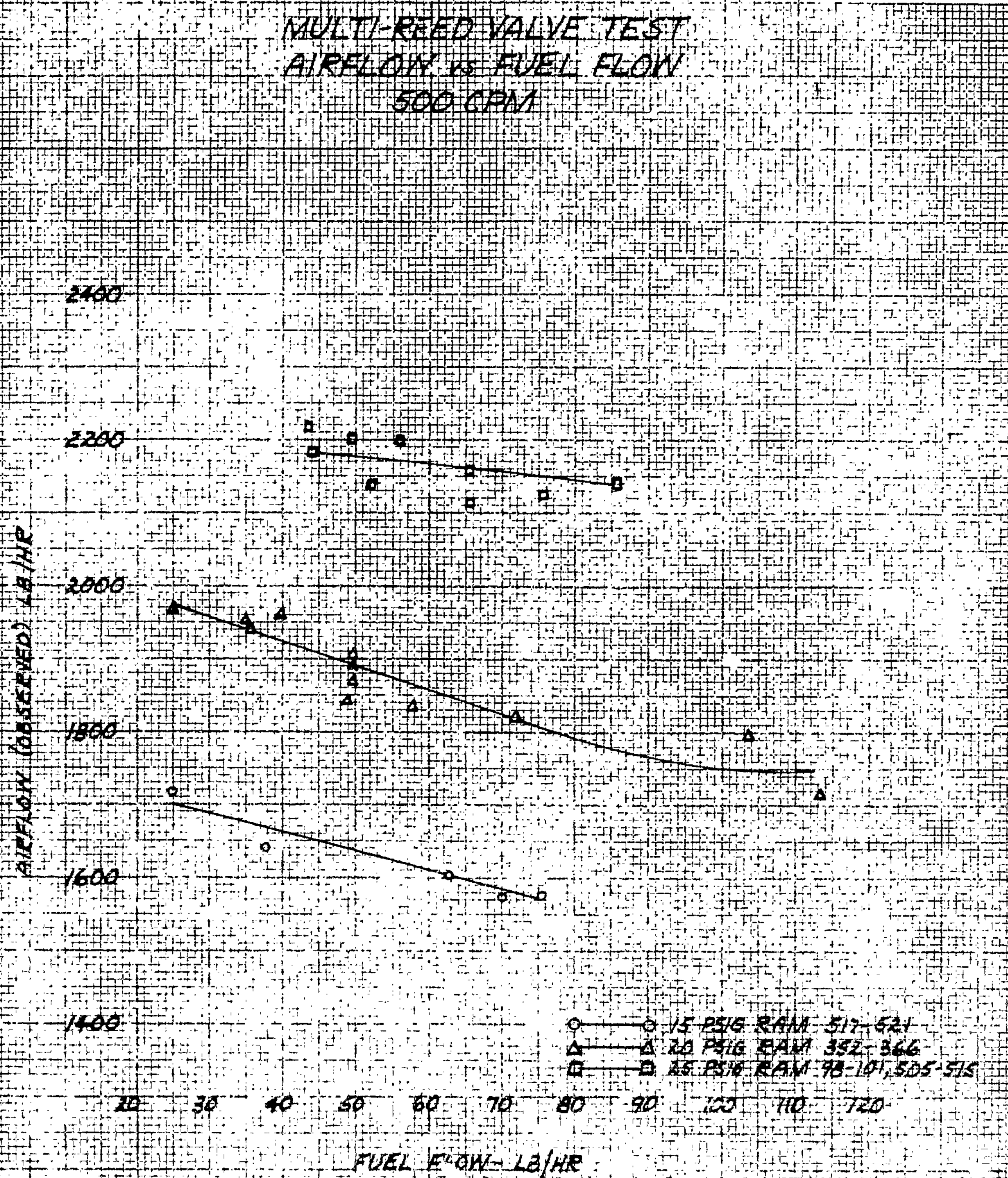

LYCOMING
Division - The Aviation Corporation
REPORT NO. 1097
CURVE NO. 7417
MULTI-REED VALVE TEST
THRUST vs FUEL FLOW
1000 CPM
IND. THRUST - LB
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
30
40
50
60
70
80
90
100
110
120
FUEL FLOW - LB/HR
15 PSIG RAM 564-570
25 PSIG RAM 246-250
25 PSIG RAM 414-421


LYCOMING
Division - The Aviation Corporation
REPORT NO. 1097
CURVE NO. 7418
MULTI-REED VALVE TEST
THRUST-vs FUEL FLOW
100 CPM
IND THRUST-LB
50
48
46
44
42
40
38
36
34
32
30
28
15 PSIG RAM
20 PSIG RAM
25 PSIG RAM 424-429
50 60 70 80 90 100 110 120 130 140
FUEL FLOW-LB/HR


LYCOMING
Division - The Aviation Corporation
REPORT NO. 1097
CURVE NO. 7419
MULTI-REED VALVE TEST
THRUST vs FUEL FLOW
1200 CPM
IND THRUST-LB
40
38
36
34
32
30
28
26
24
15 PSIG RAM 578-584
26 PSIG RAM 263
40
50
60
70
80
90
100
110
120
130
140
FUEL FLOW-LB/HR

LYCOMING
Division - The Aviation Corporation

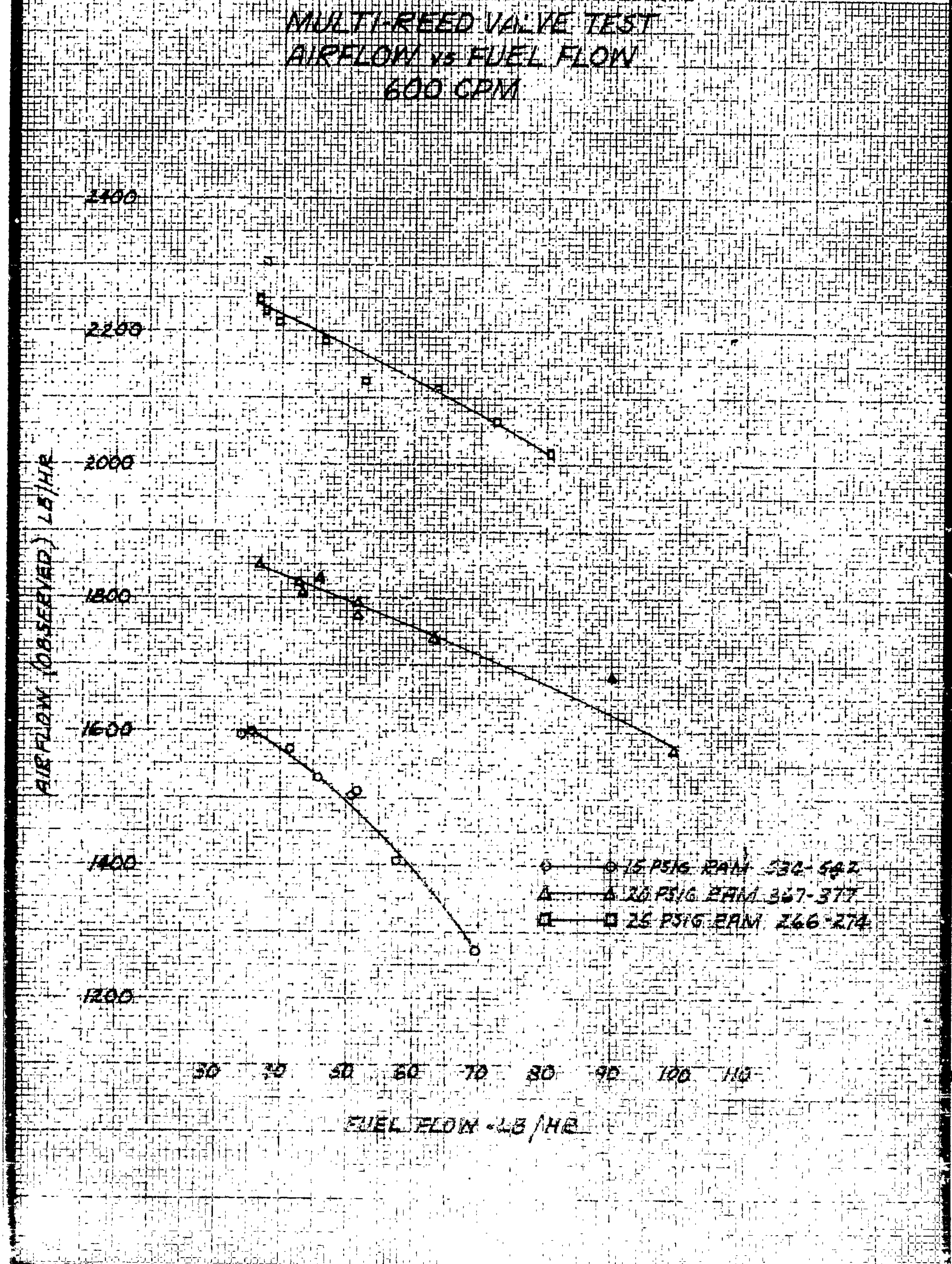
REPORT NO. 1097
CURVE NO. 7420



Form-673

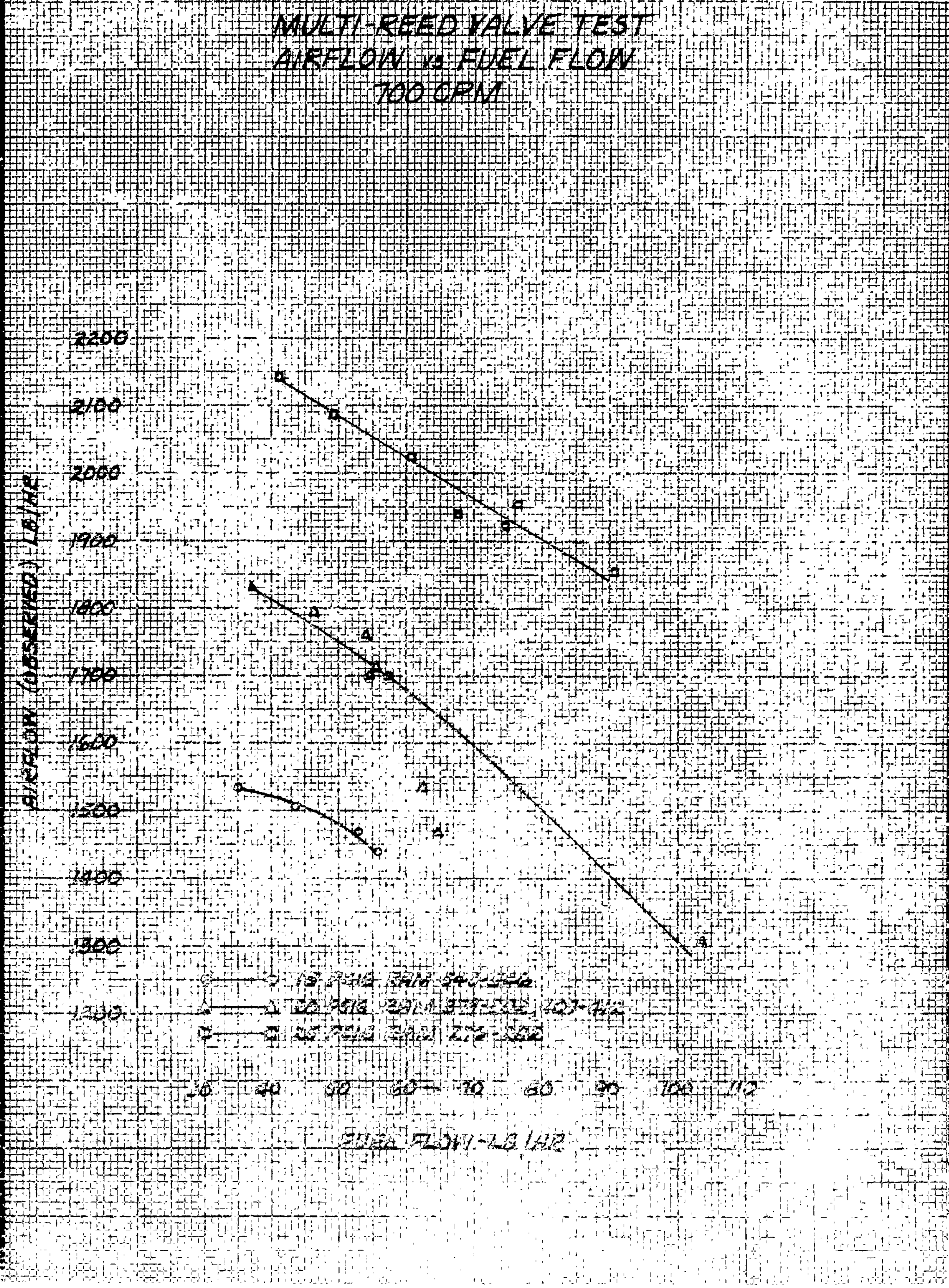
LYCOMING
Division - The Aviation Corporation

REPORT NO. 1097
CURVE NO. 7421



LYCOMING
Division - The Aviation Corporation

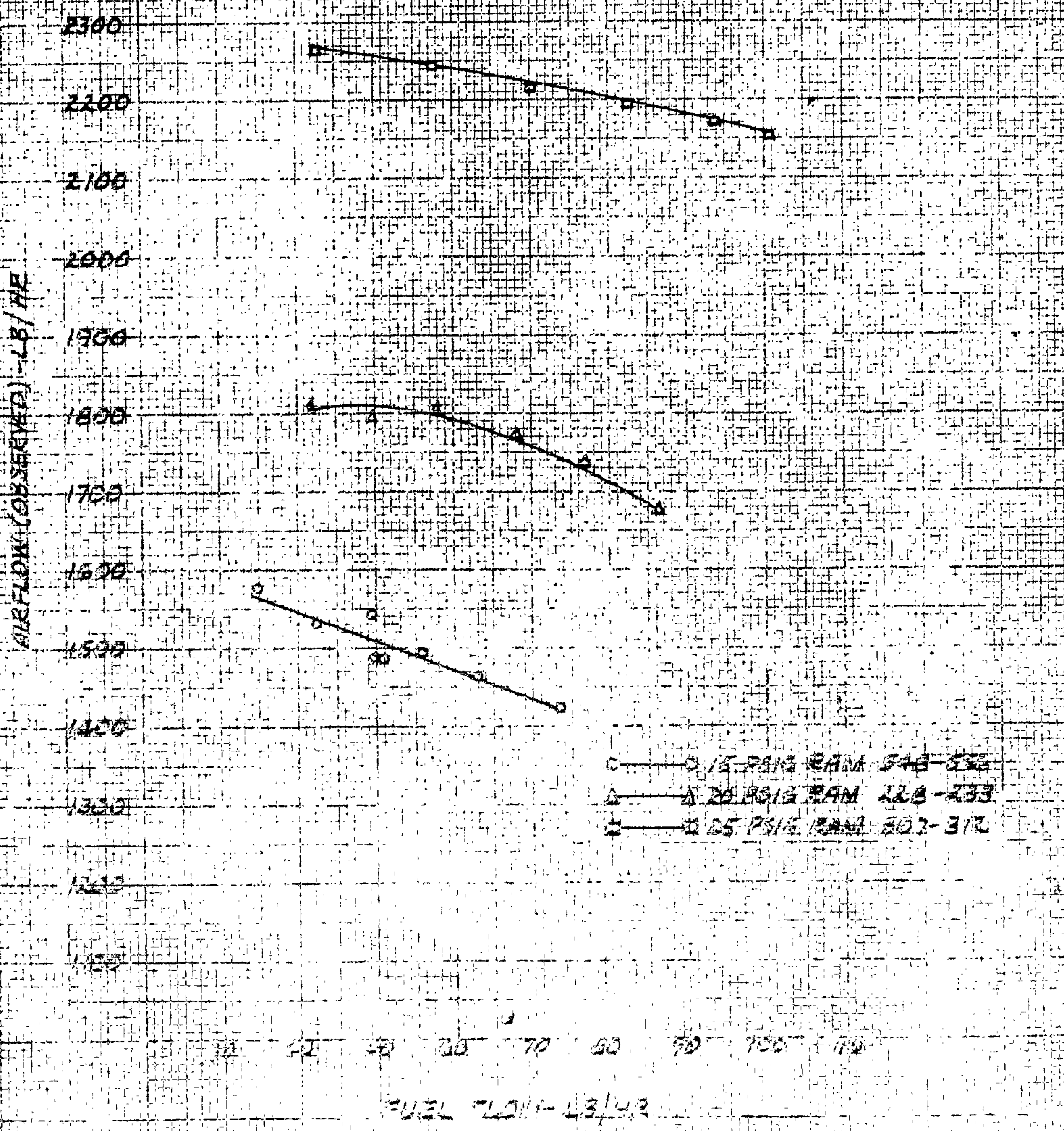
REPORT NO. 1097
CURVE NO. 7422

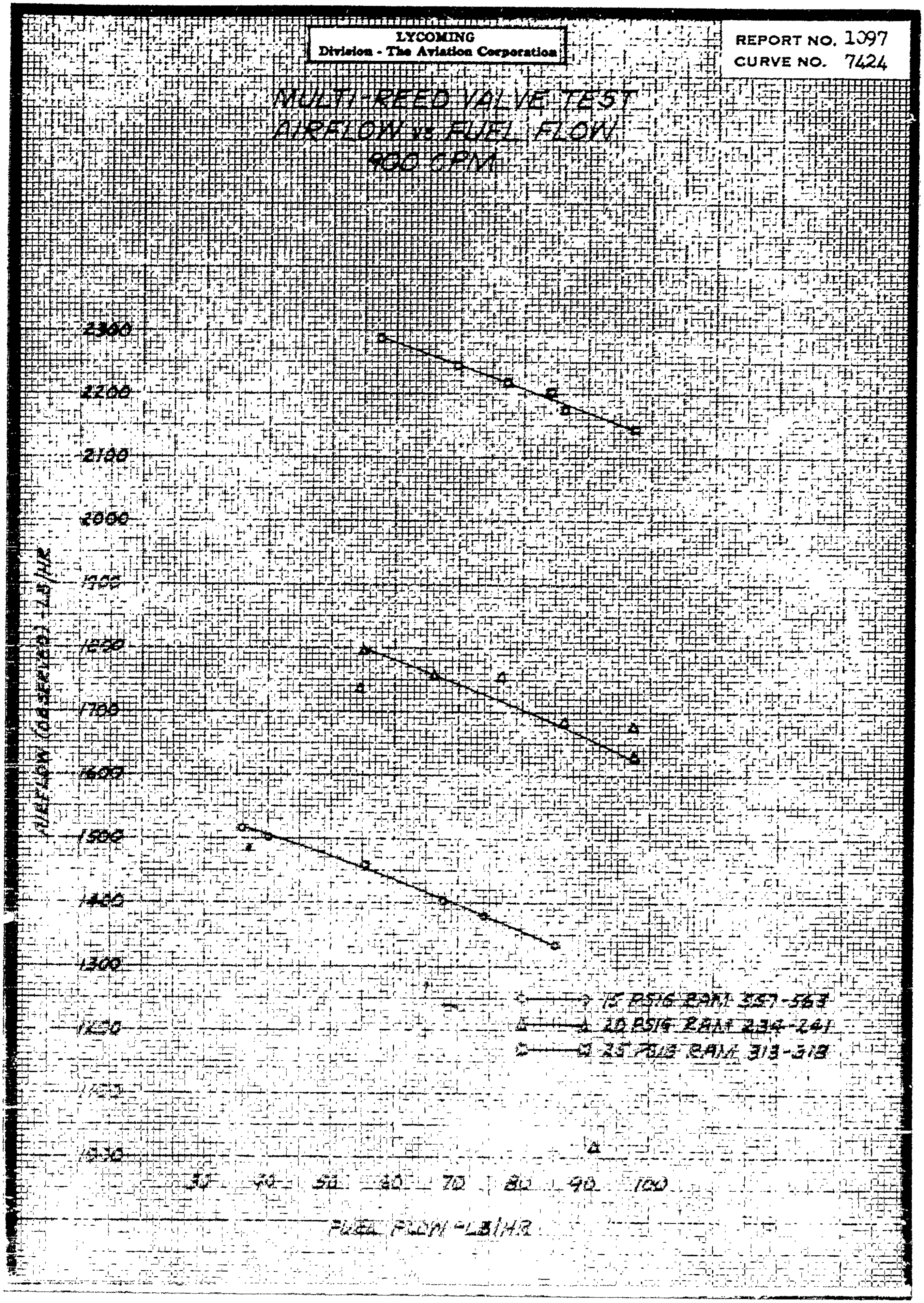


LYCOMING
Division - The Aviation Corporation

REPORT NO. 1097
CURVE NO. 7423

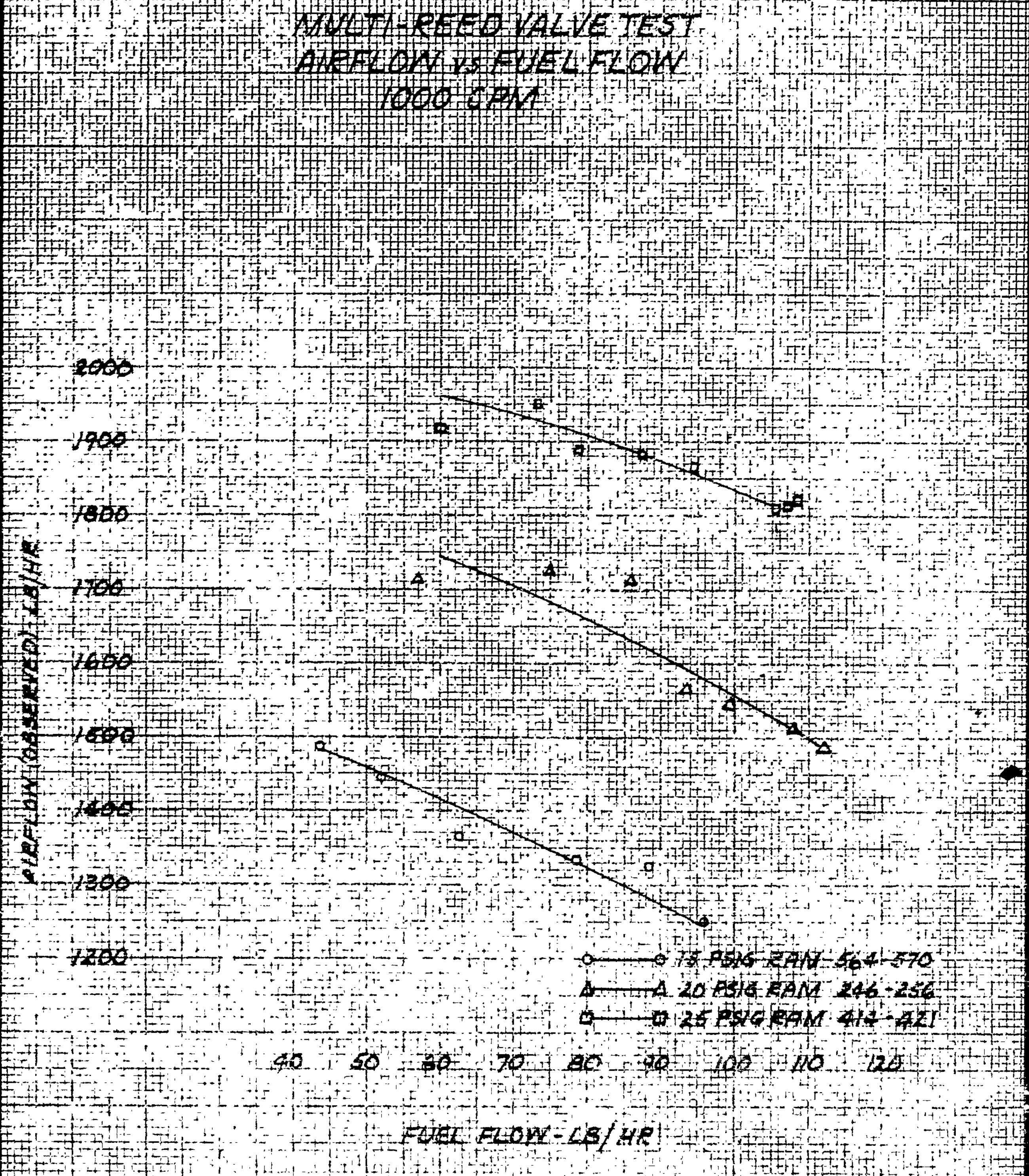
MULTI-REED VALVE TEST
AIRFLOW vs FUEL FLOW
800 CPM




LYCOMING
Division - The Aviation Corporation
REPORT NO. 1097
CURVE NO. 7424
MULTI-REED VALVE TEST
AIRFLOW vs FUEL FLOW
900 CPM
AIRFLOW (OBSERVED) - LB/HR
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1000
30
40
50
60
70
80
90
100
FUEL FLOW - LB/HR
15 PSIG RAM 557-563
20 PSIG RAM 234-241
25 PSIG RAM 313-318

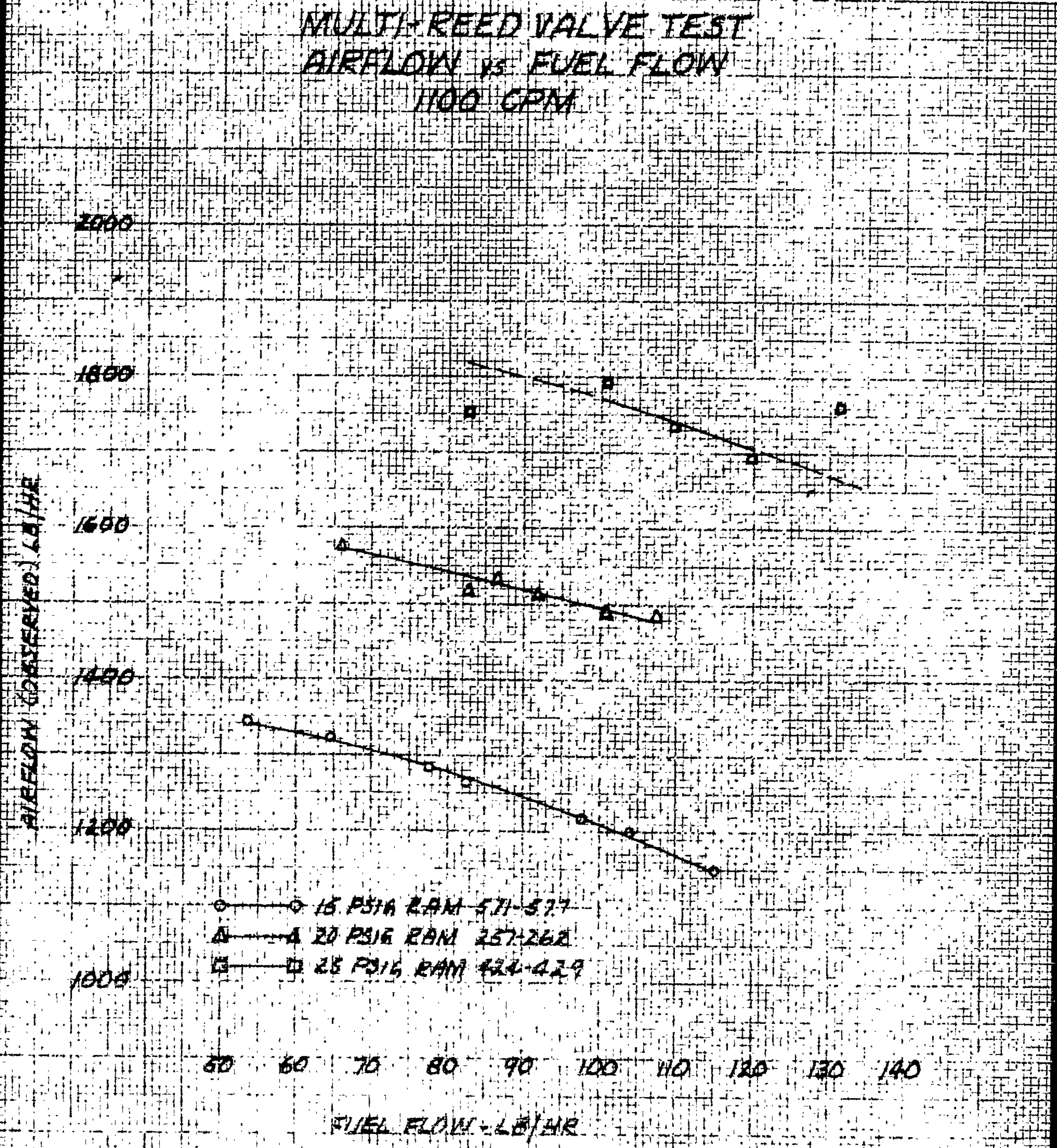
LYCOMING
Division - The Aviation Corporation

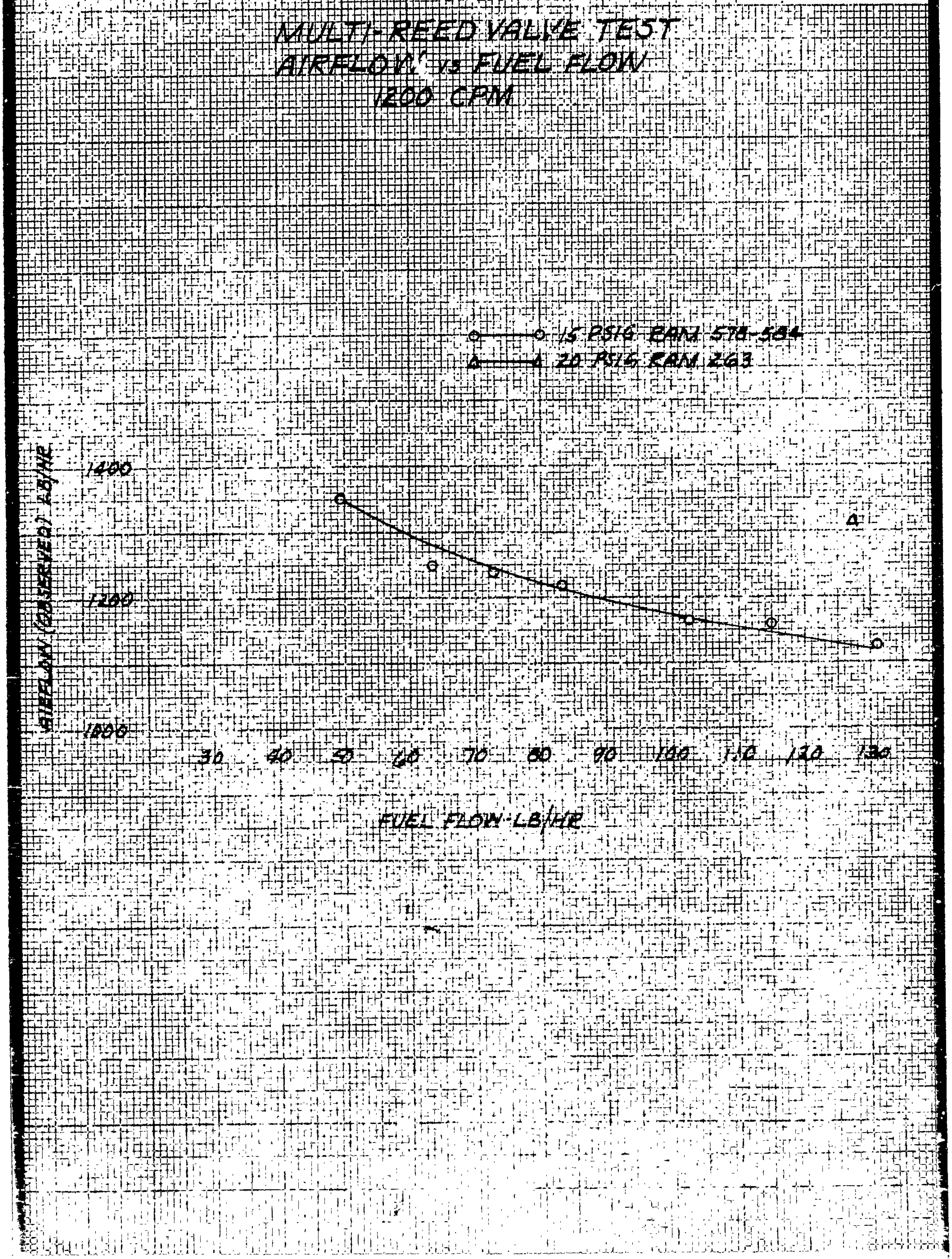
REPORT NO. 1097
CURVE NO. 7425



LYCOMING
Division - The Aviation Corporation

REPORT NO. 1097
CURVE NO. 7426




MULTI-REED VALVE TEST
AIRFLOW vs FUEL FLOW
1200 CPM
15 PSIG RAN 578-584
20 PSIG RAN 263
AIRFLOW (OBSERVED) LB/HR
1400
1200
1000
30
40
50
60
70
80
90
100
110
120
130
FUEL FLOW LB/HR

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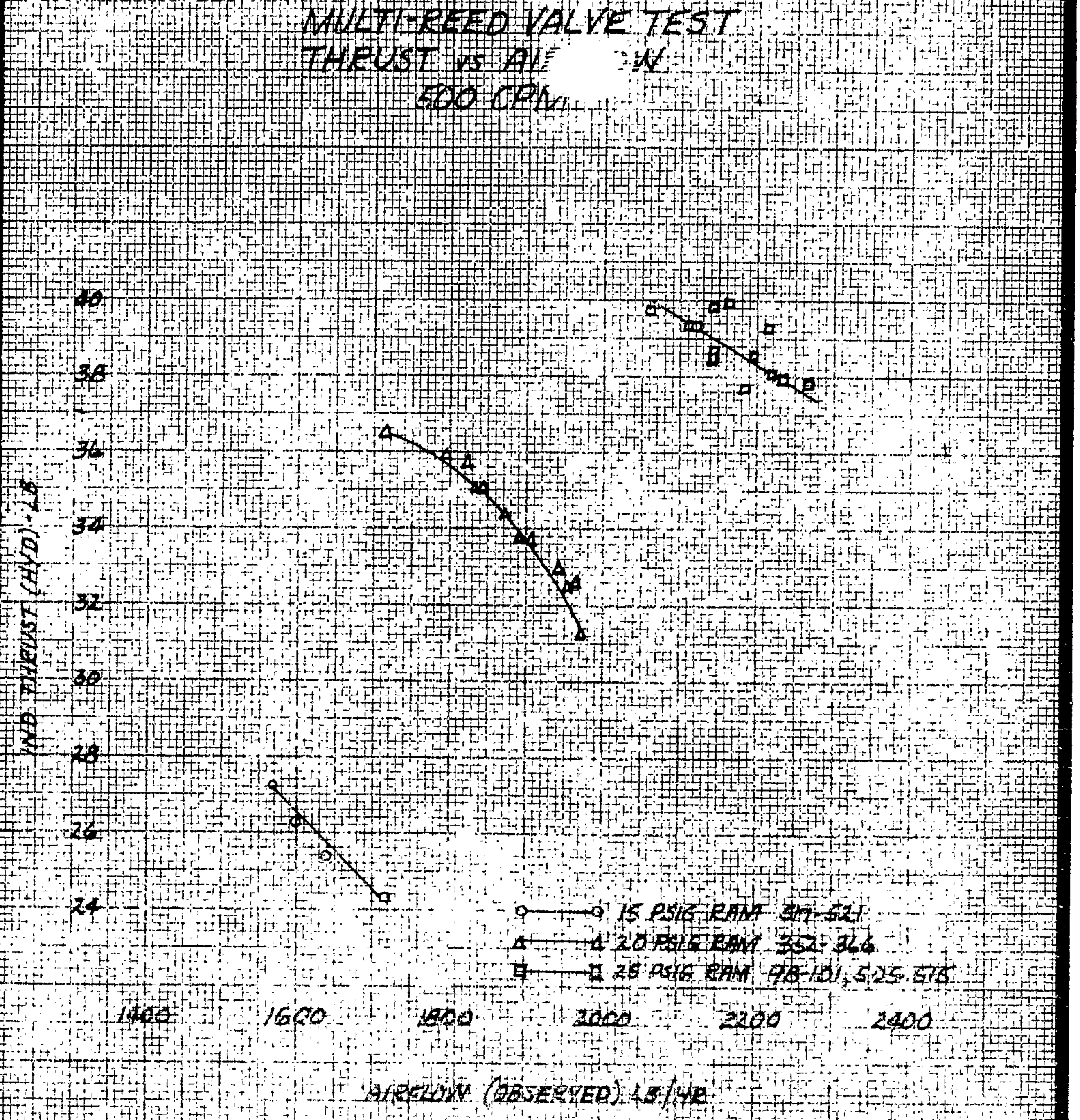
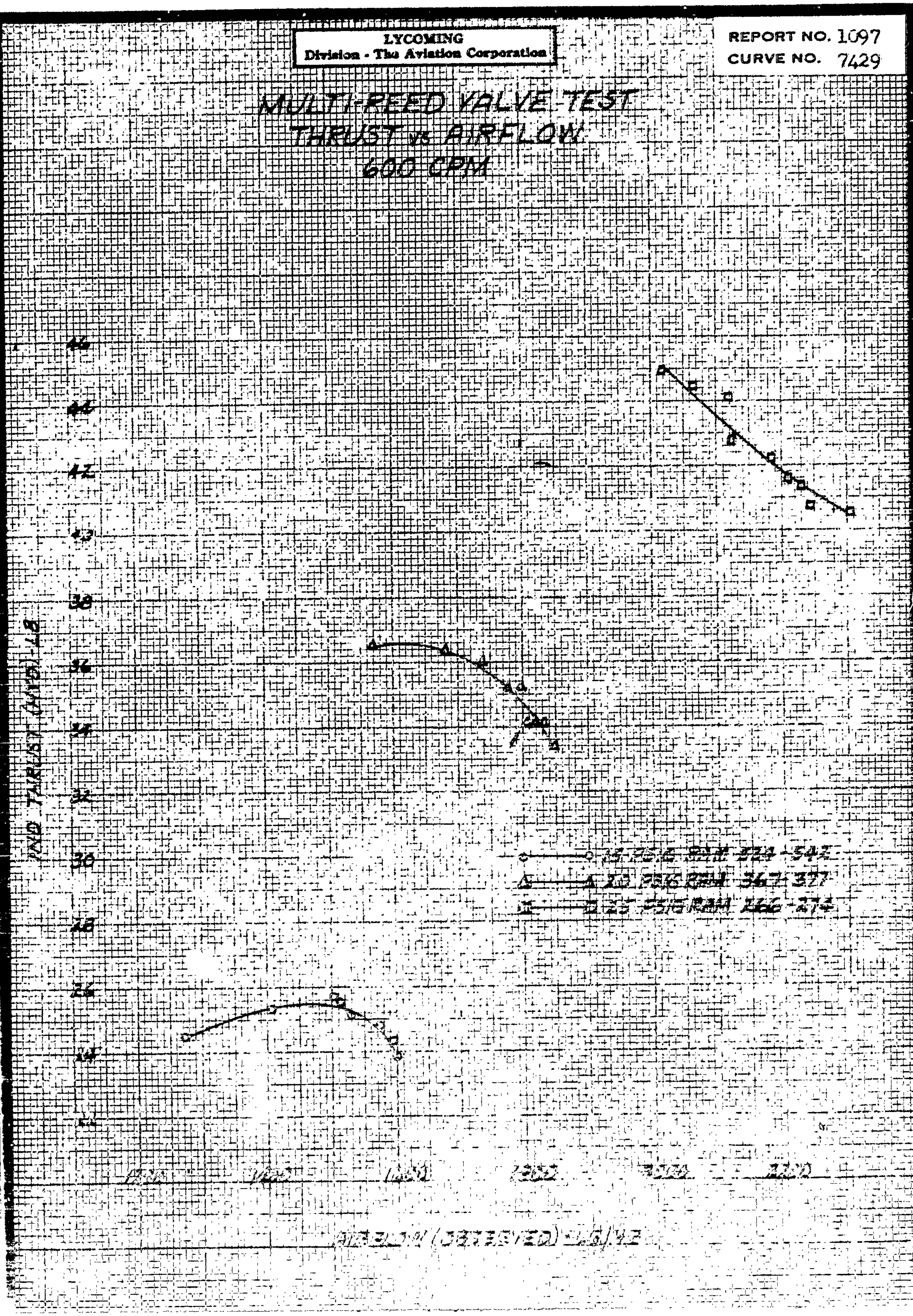
Division - The Aviation Corporation

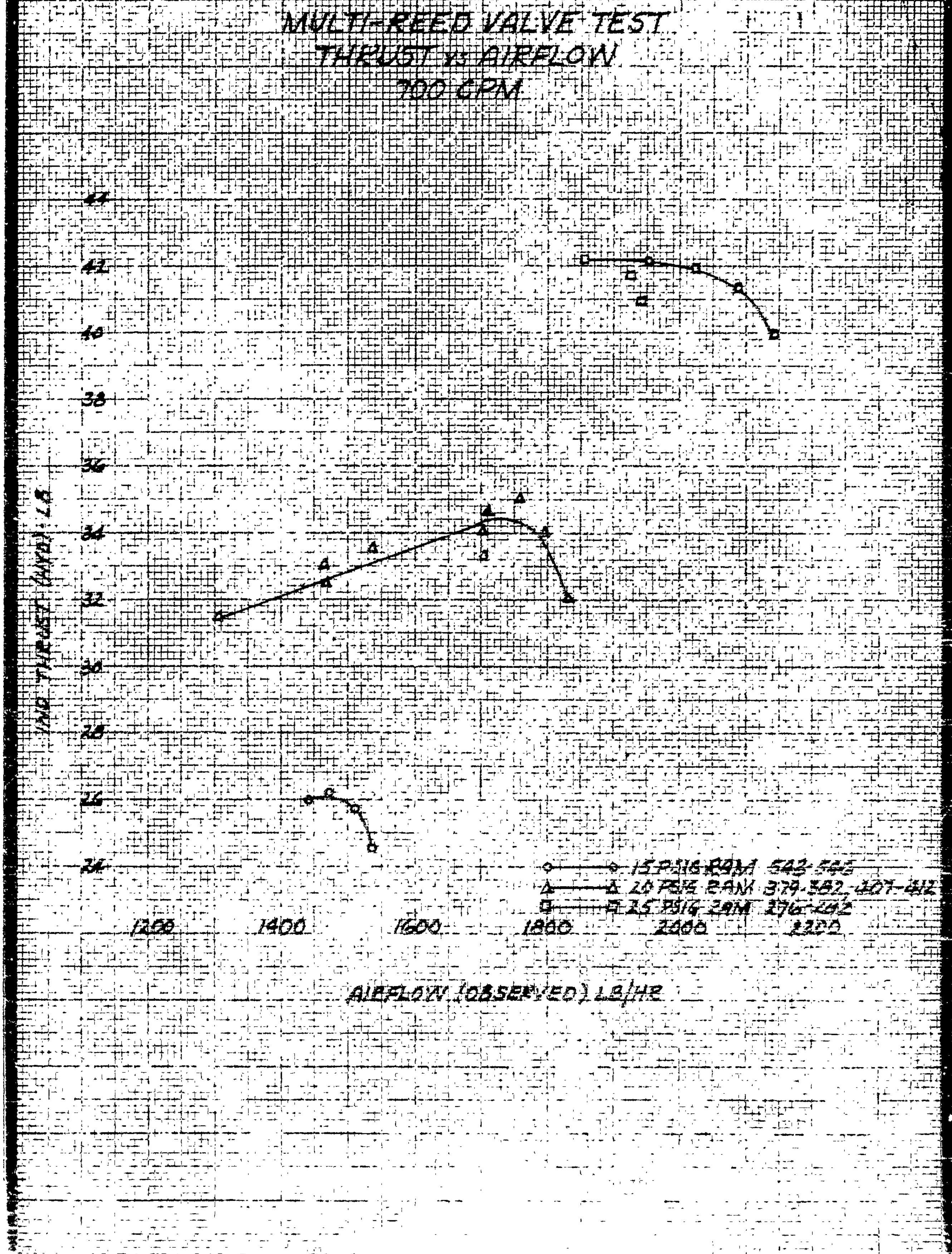
REPORT NO. 1097
CURVE NO. 7428




LYCOMING
Division - The Aviation Corporation
REPORT NO. 1097
CURVE NO. 7429
MULTI-REED VALVE TEST
THRUST vs AIRFLOW
600 CPM
46
44
42
38
36
34
32
30
28
26
24

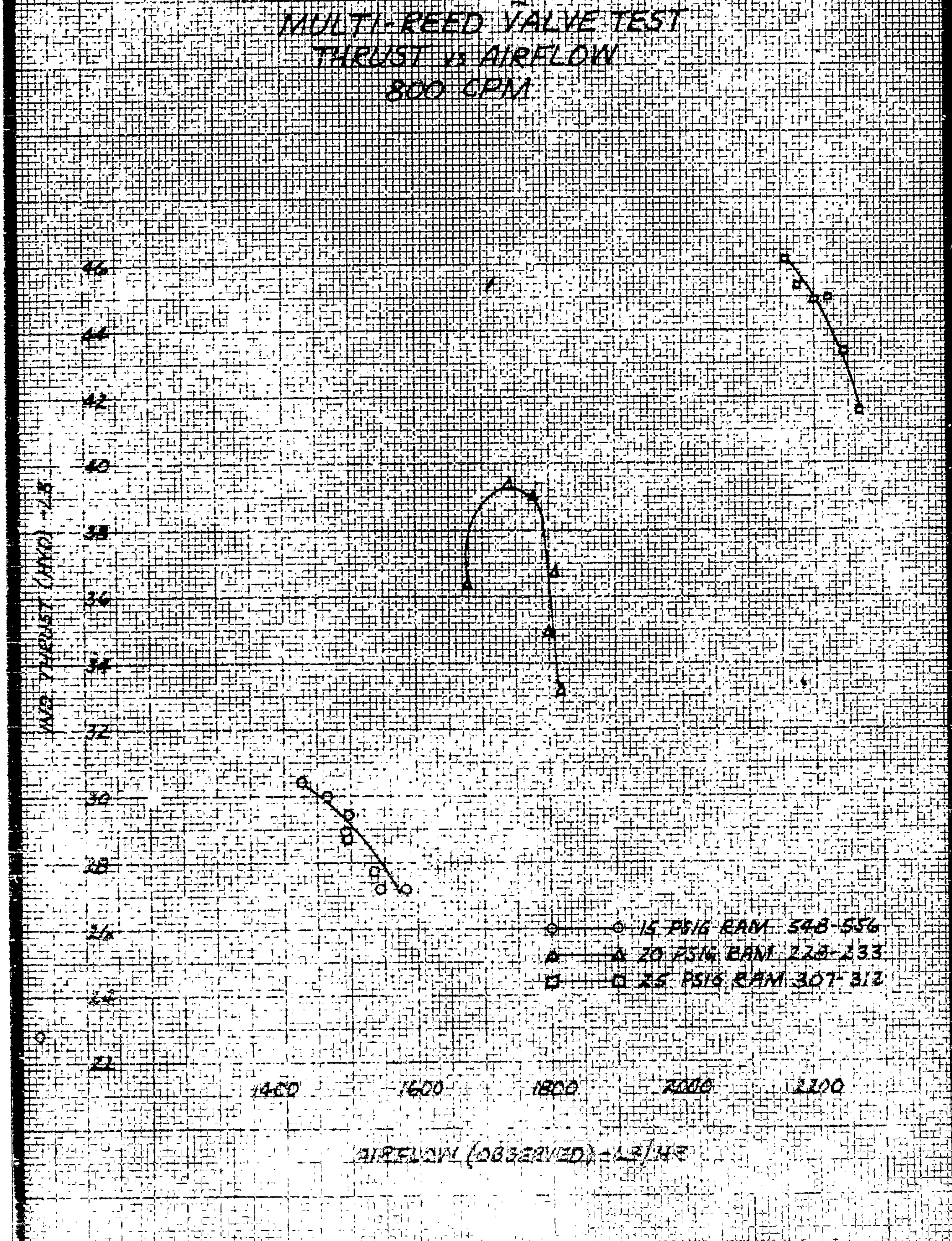
LYCOMING
Division - The Aviation Corporation

REPORT NO. 1097
CURVE NO. 7430



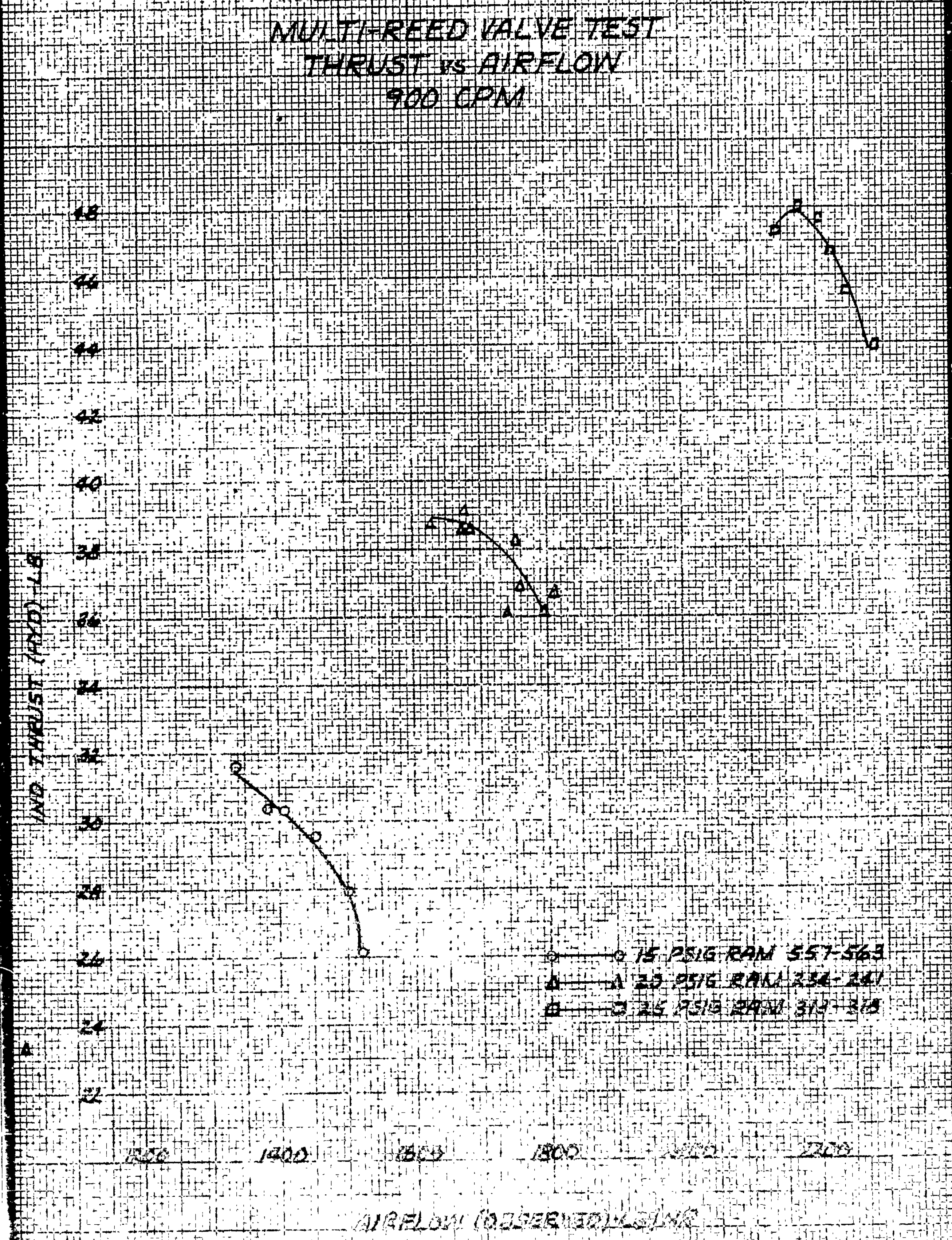
LYCOMING
Division - The Aviation Corporation

REPORT NO. 1097
CURVE NO. 7431



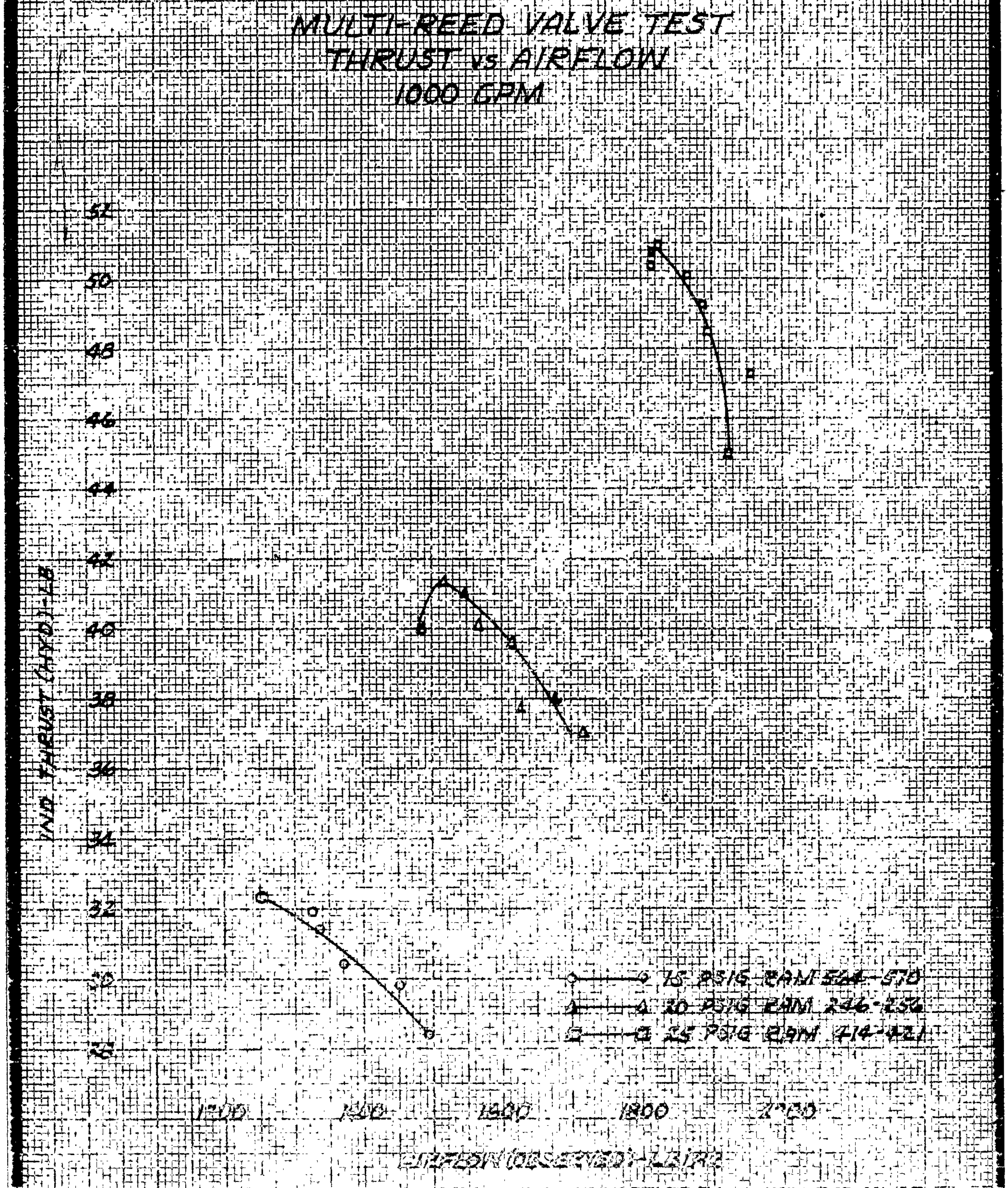
LYCOMING
Division - The Aviation Corporation

REPORT NO. 1097
CURVE NO. 7432



LYCOMING
Division - The Aviation Corporation

REPORT NO. 1097
CURVE NO. 7433

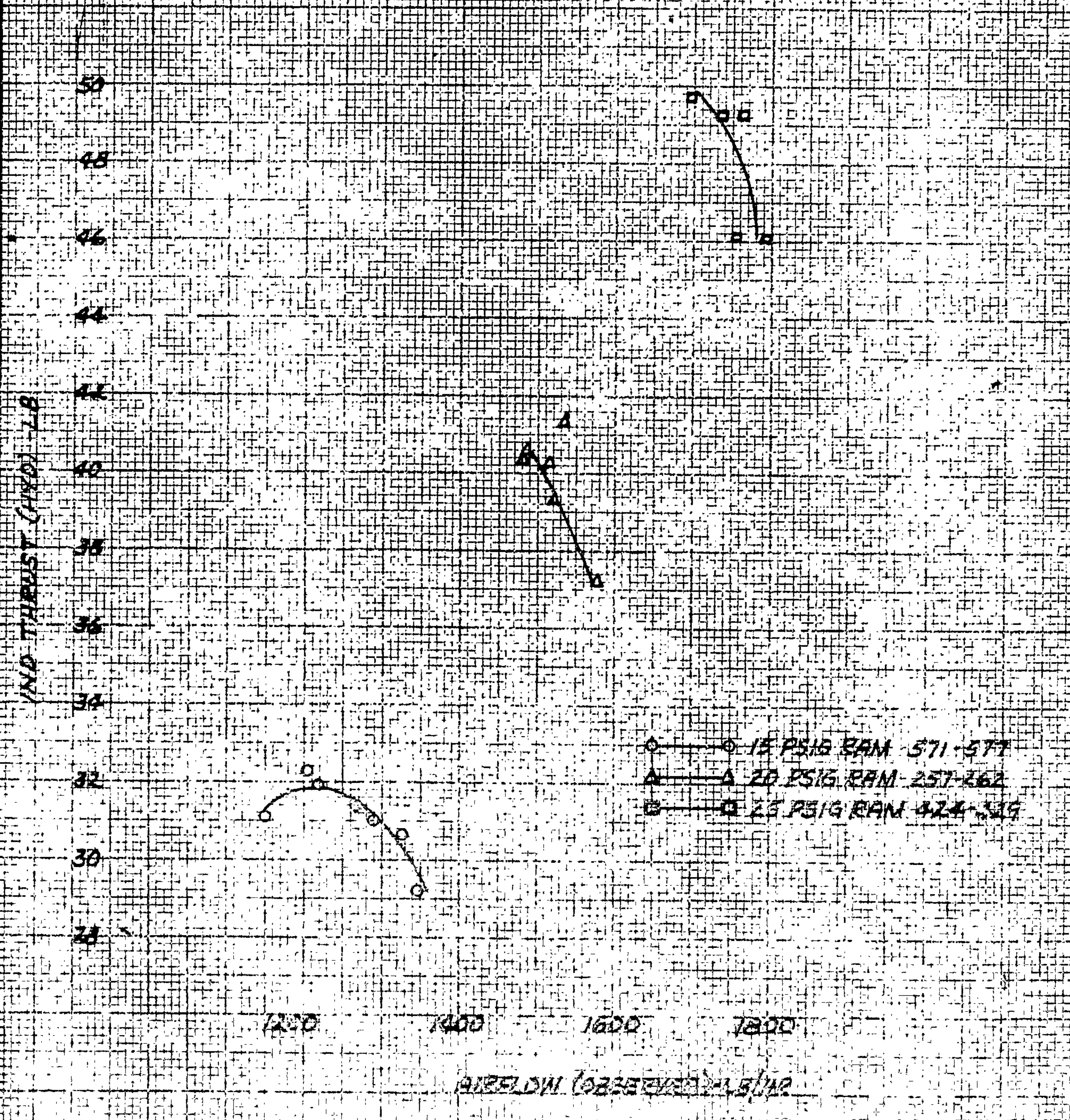


Form-673

LYCOMING
Division - The Aviation Corporation

REPORT NO. 1097
CURVE NO. 7434

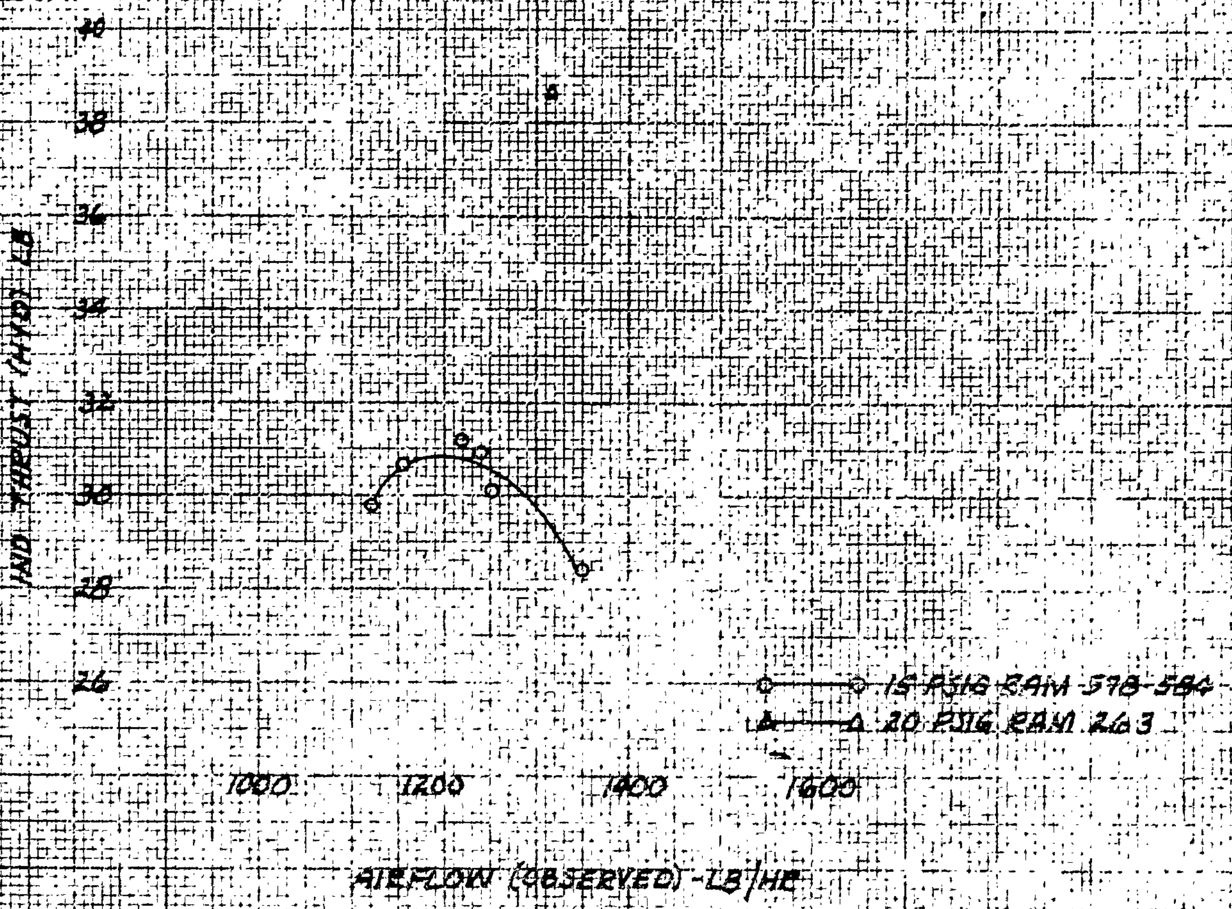
MULTI-REED VALVE TEST
THRUST vs AIRFLOW
1100 CPM

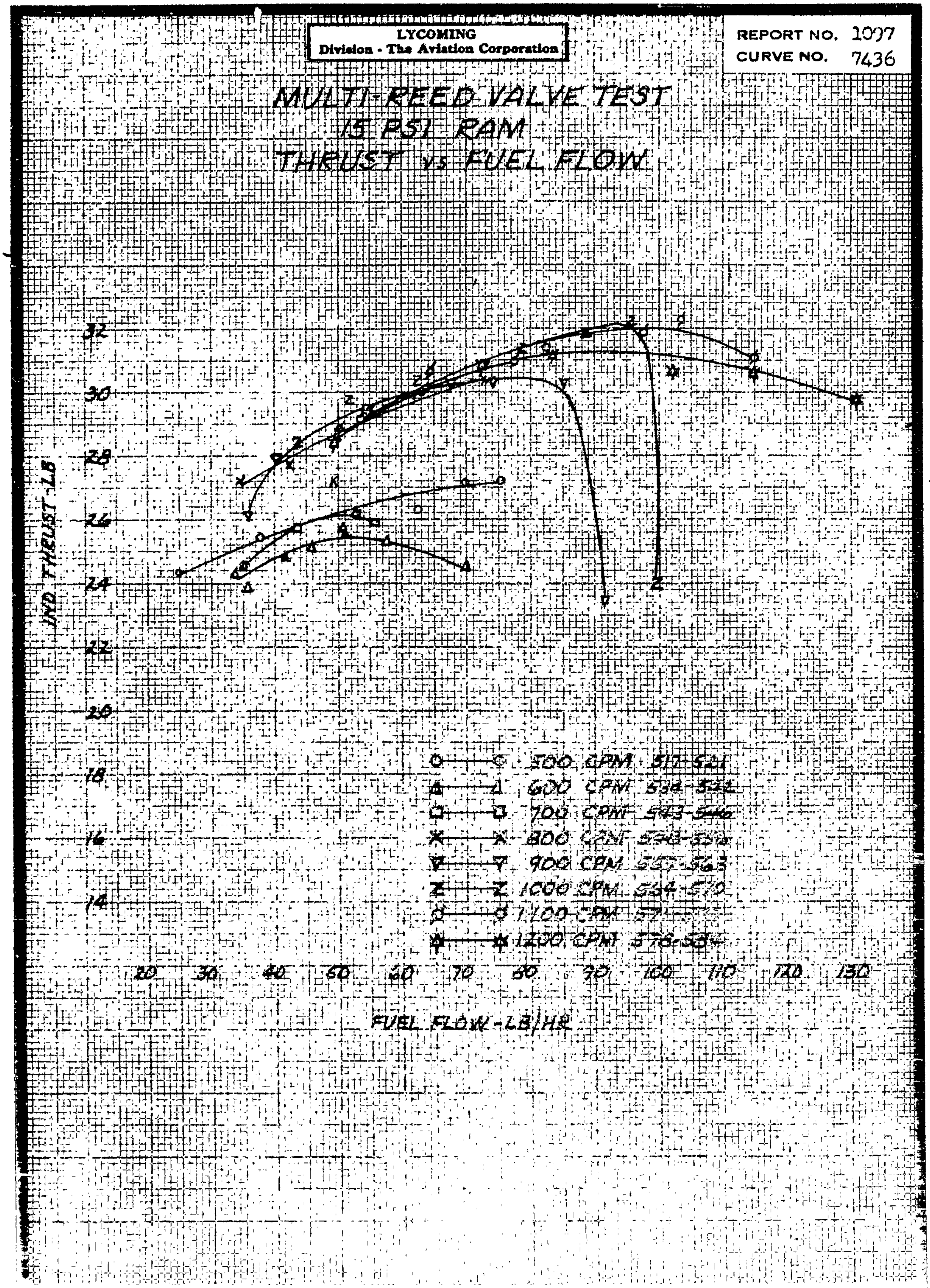


LYCOMING
Division - The Aviation Corporation

REPORT NO. 1097
CURVE NO. 7435

MULTI-REED VALVE TEST
THRUST vs AIRFLOW
1200 CPM

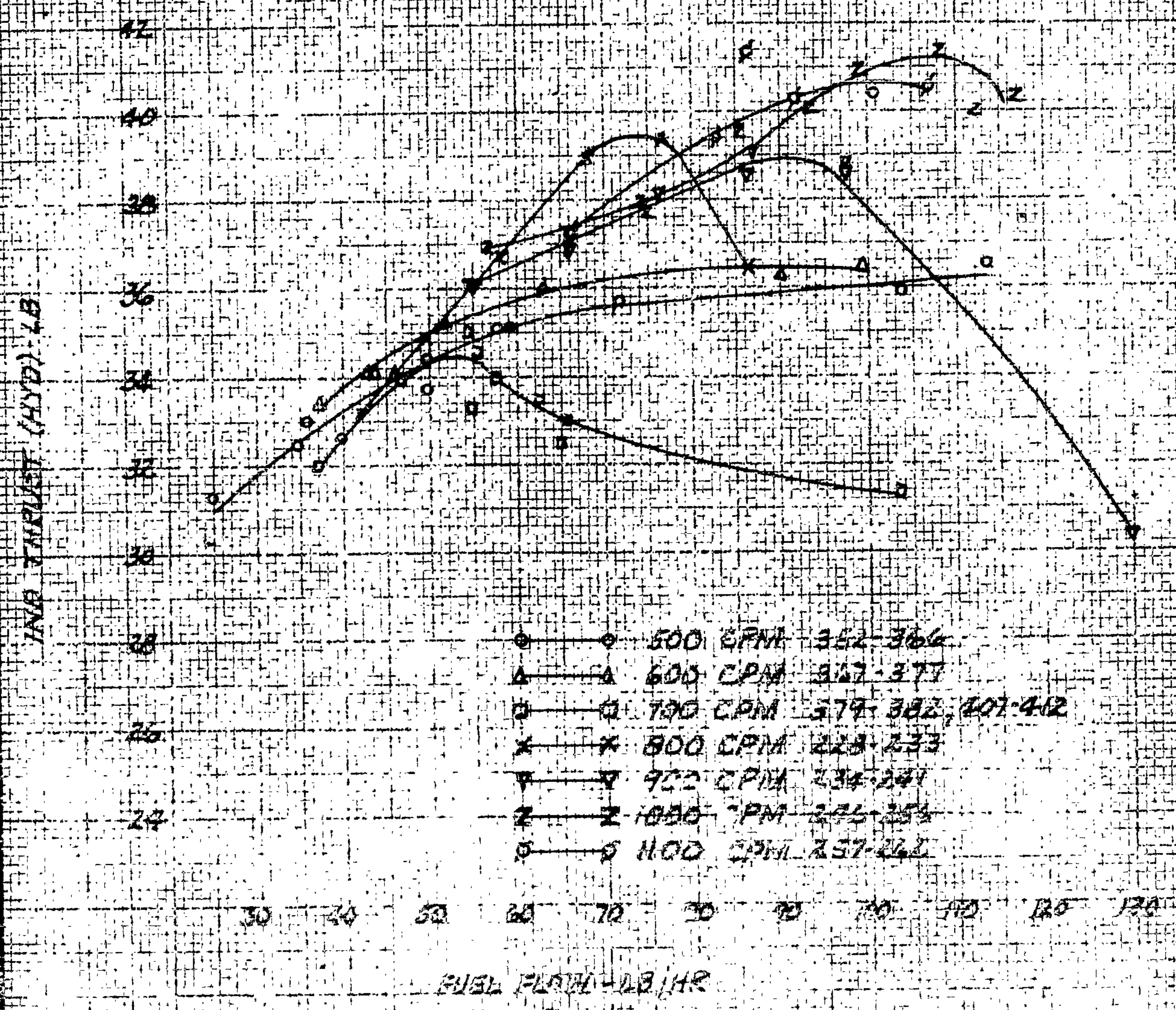



LYCOMING
Division - The Aviation Corporation
REPORT NO. 1097
CURVE NO. 7436
MULTI-REED VALVE TEST
15 PSI RAM
THRUST vs FUEL FLOW
IND THRUST - LB
32
30
28
26
24
22
20
18
16
14
500 CPM 517-521
600 CPM 538-542
700 CPM 543-546
800 CPM
900 CPM 557-563
1000 CPM 564-570
1100 CPM
1200 CPM 578-584
20
30
40
50
60
70
80
90
100
110
120
130
FUEL FLOW - LB/HR

LYCOMING
Division - The Aviation Corporation

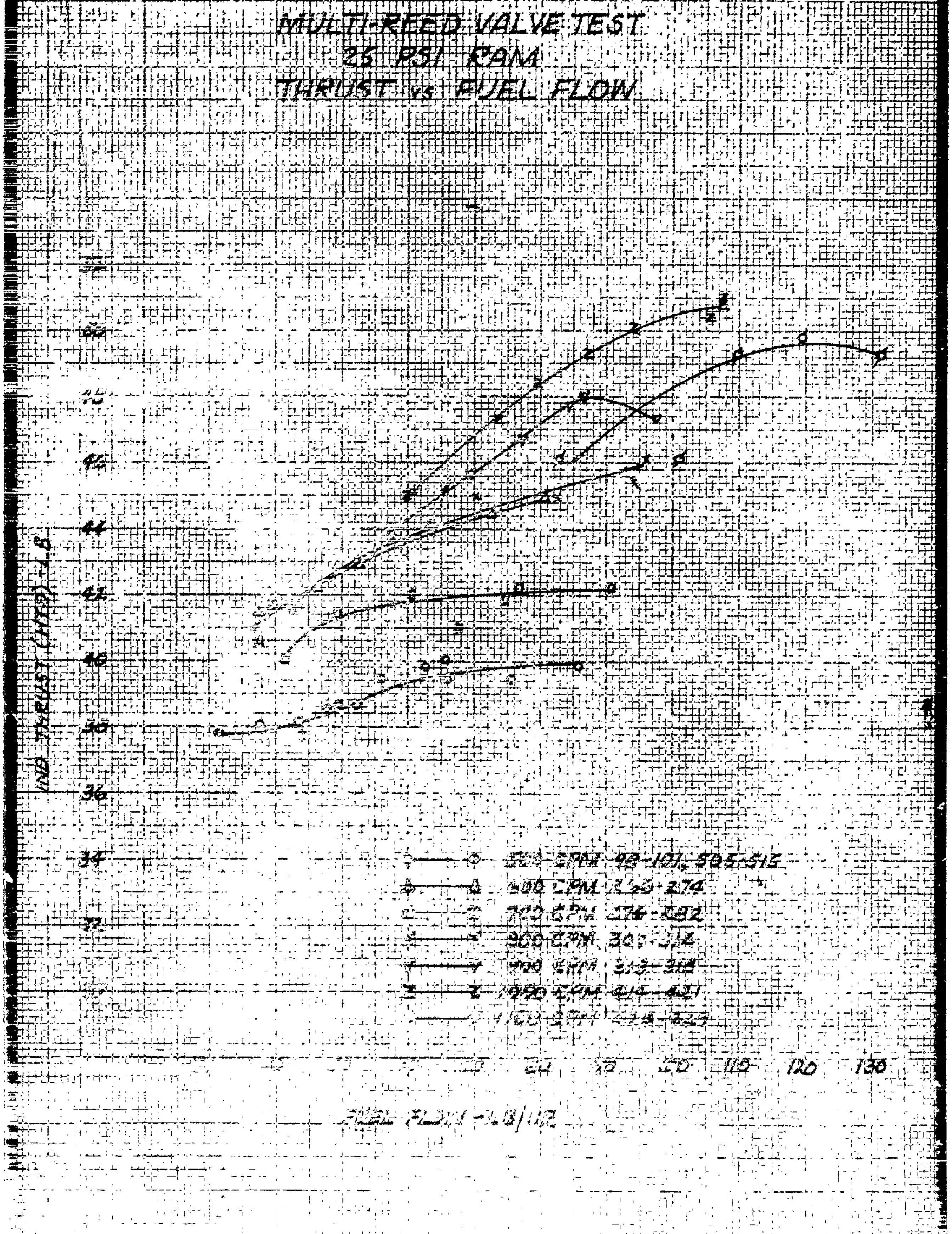
REPORT NO. 1097
CURVE NO. 7437

MULTI-REED VALVE TEST
20 PSI RAM
THRUST vs FUEL FLOW



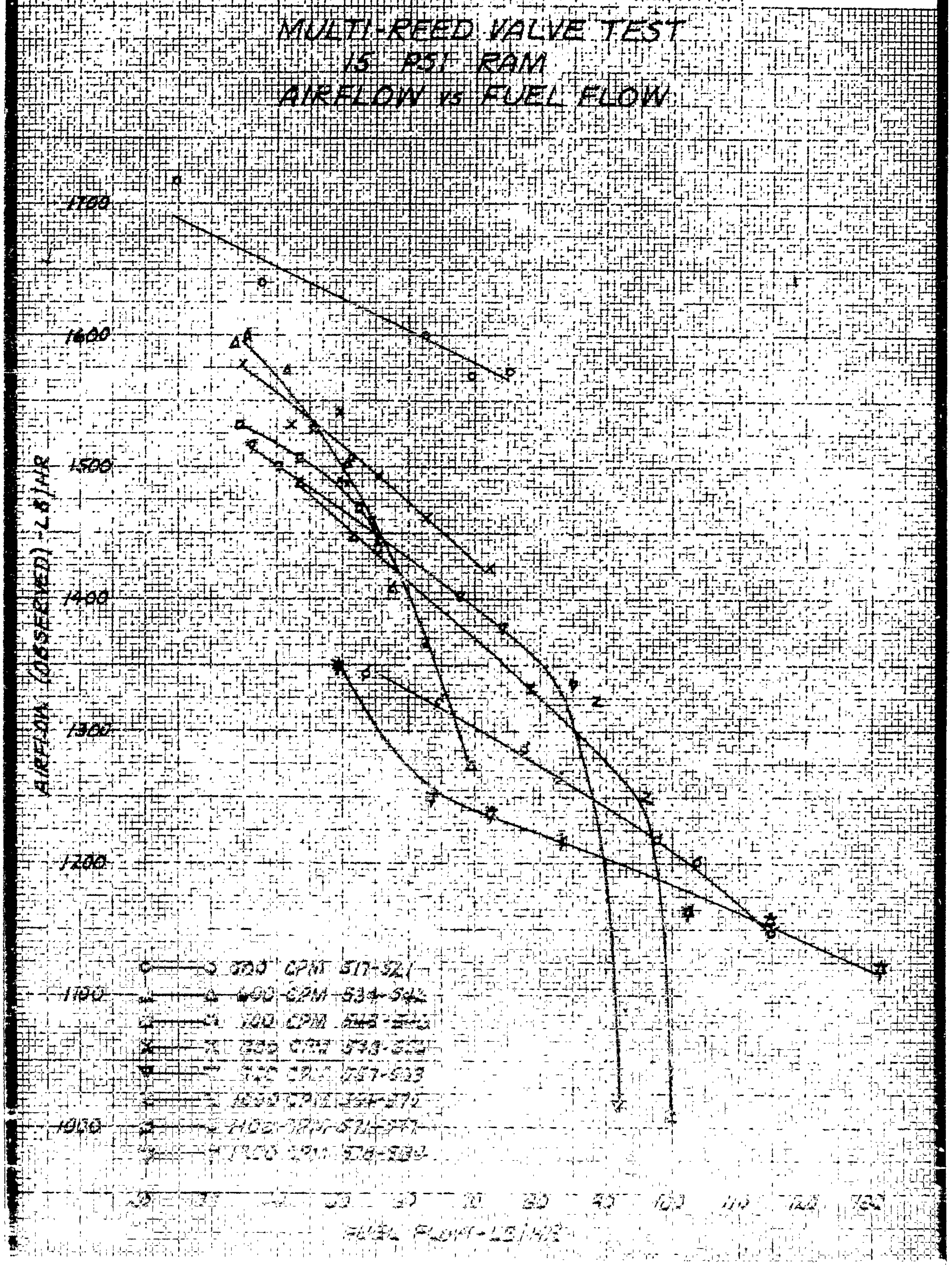
LYCOMING
Division - The Aviation Corporation

REPORT NO. 1097
CURVE NO. 7438



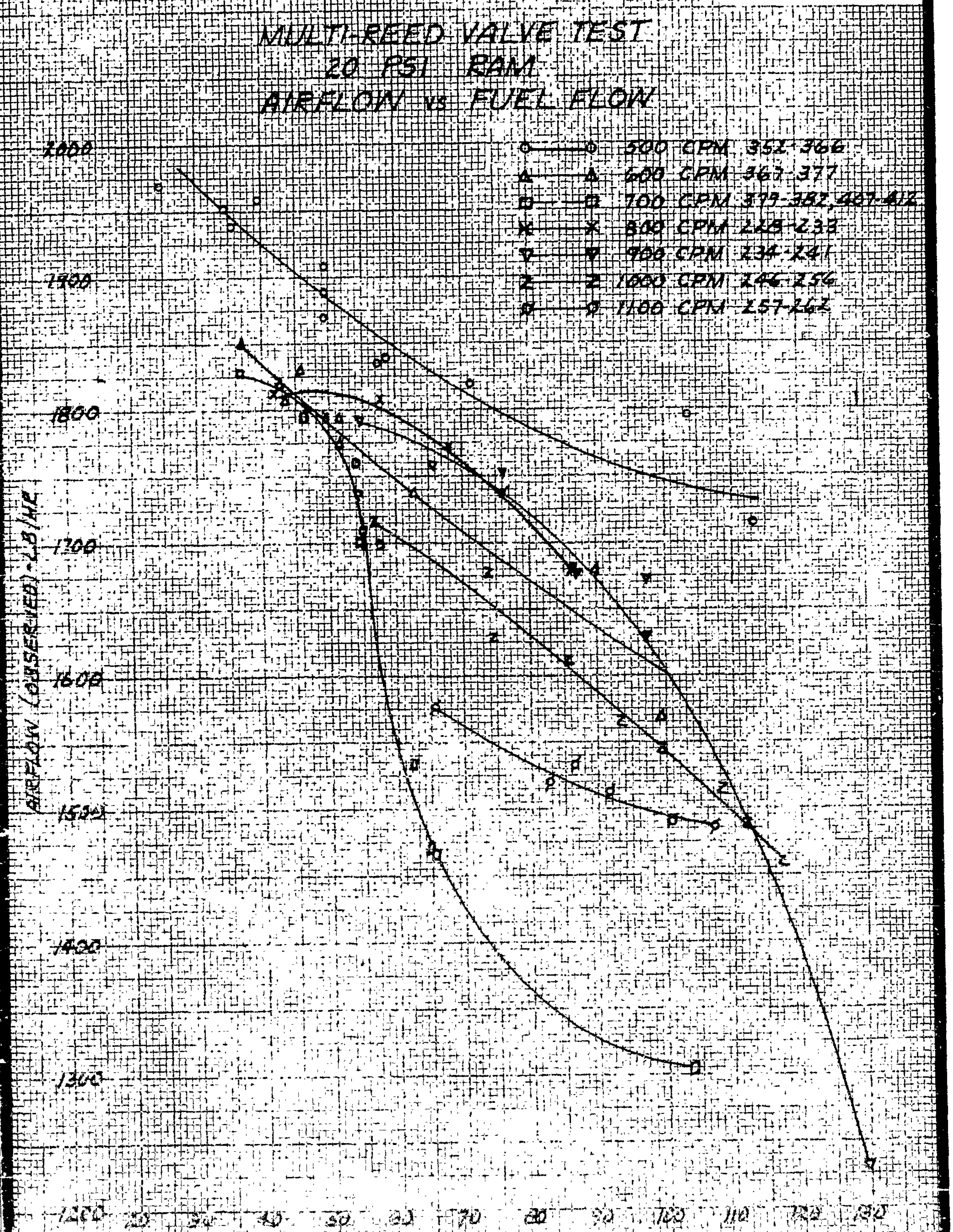
LYCOMING
Division - The Aviation Corporation

REPORT NO. 1097
CURVE NO. 7439



LYCOMING
Division - The Aviation Corporation

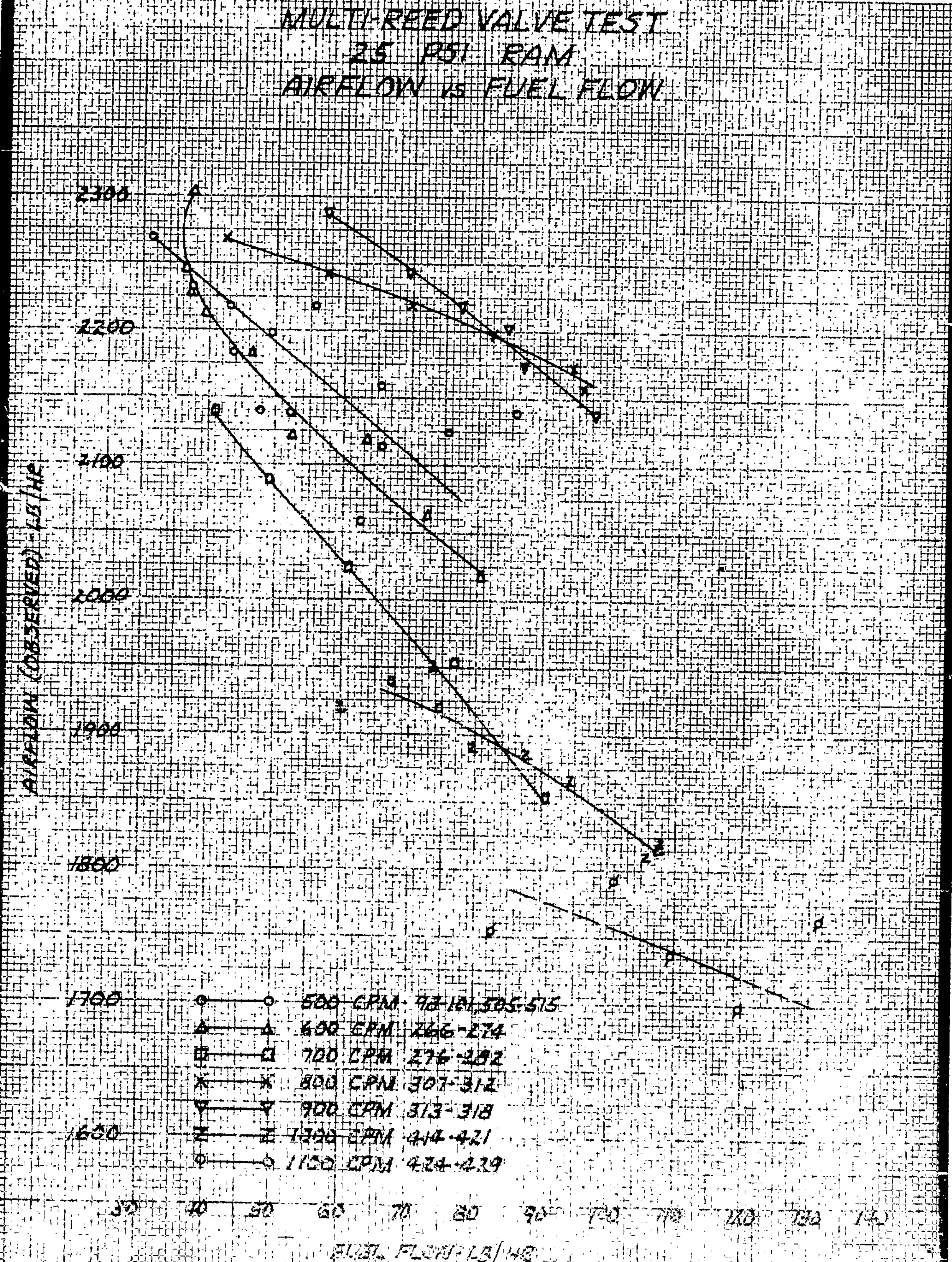
REPORT NO. 1097
CURVE NO. 7440



Form-673

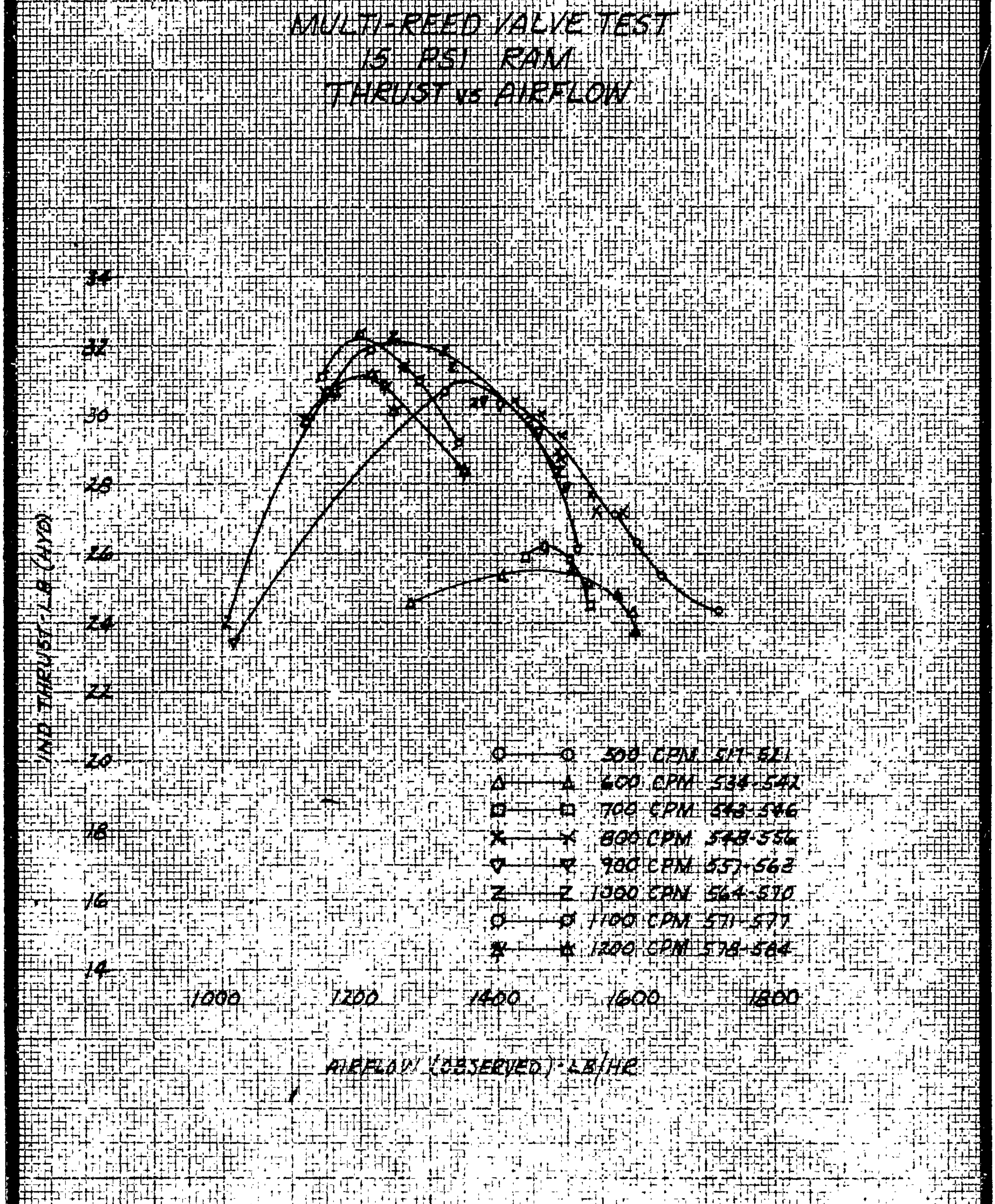
LYCOMING
Division - The Aviation Corporation

REPORT NO. 1097
CURVE NO. 7441



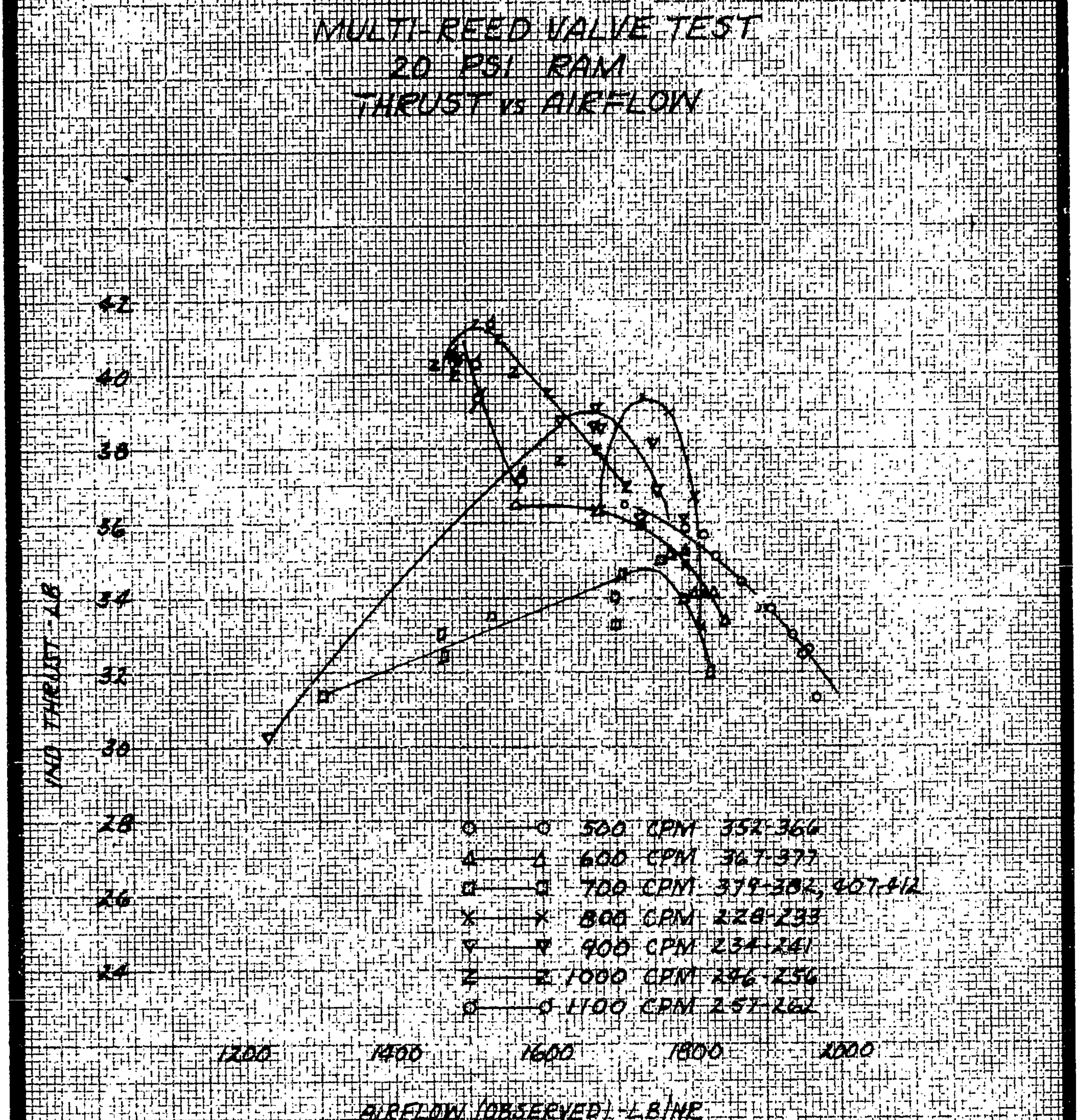
LYCOMING
Division - The Aviation Corporation

REPORT NO. 1097
CURVE NO. 7442



LYCOMING
Division - The Aviation Corporation

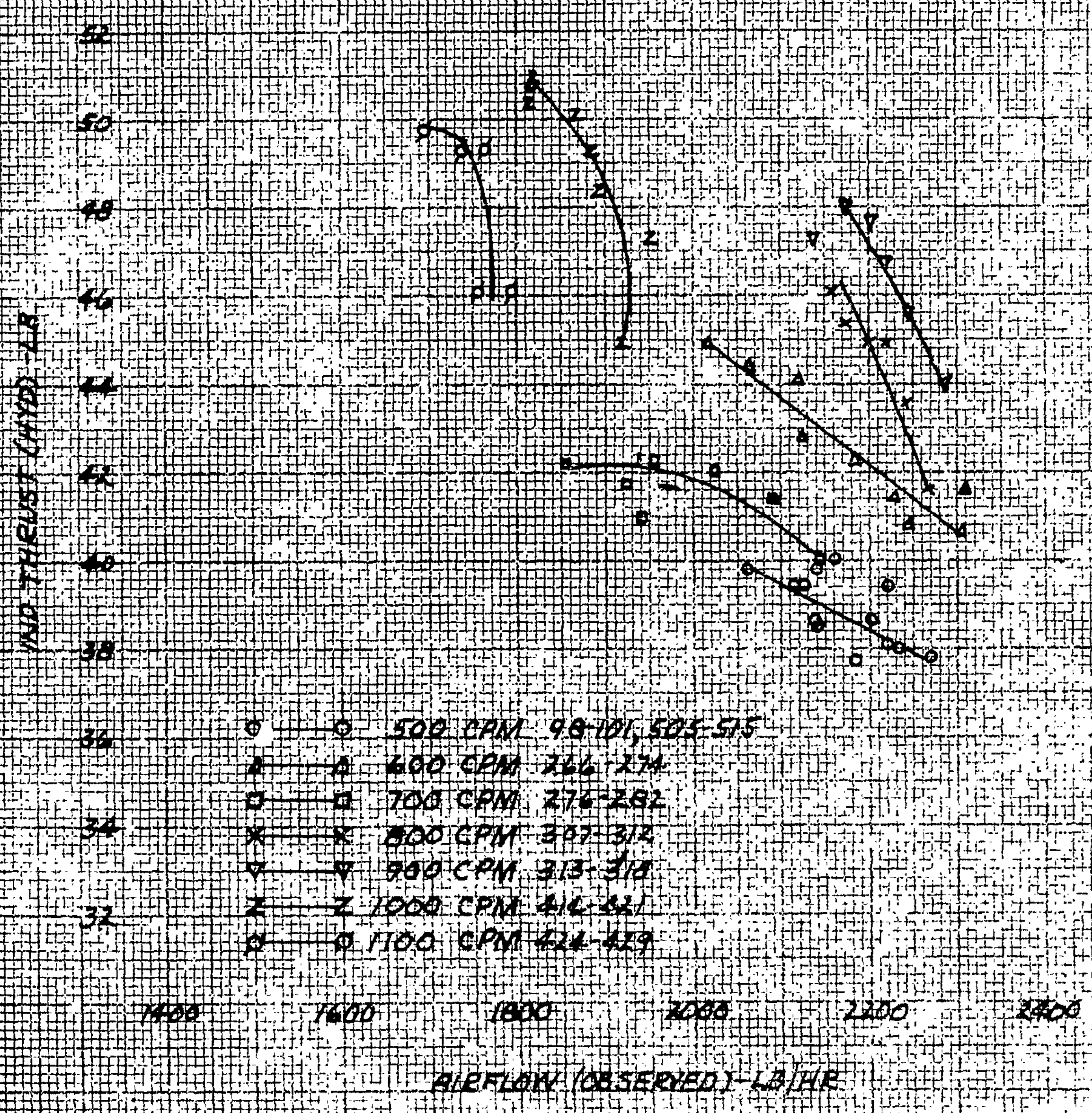
REPORT NO. 1097
CURVE NO. 7443

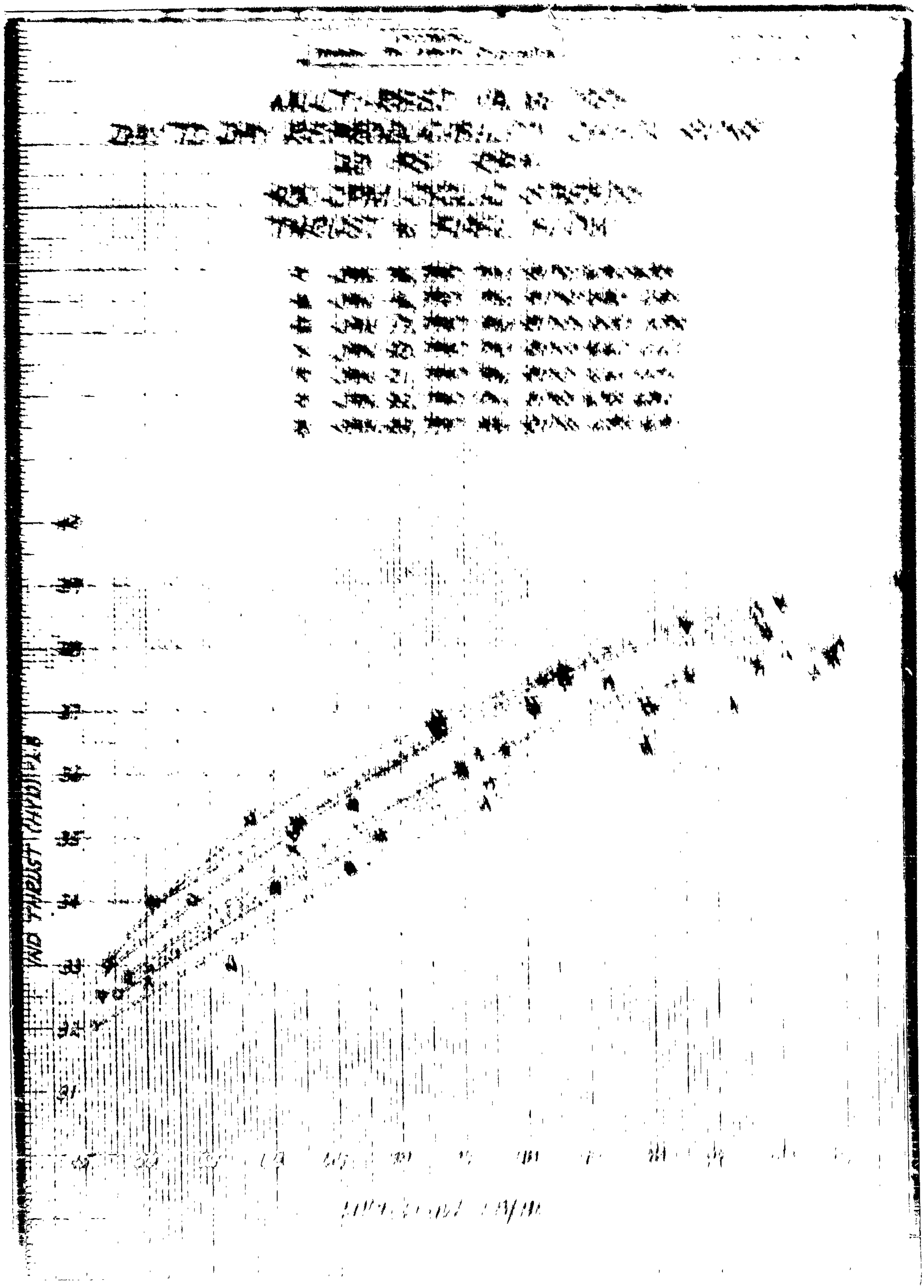


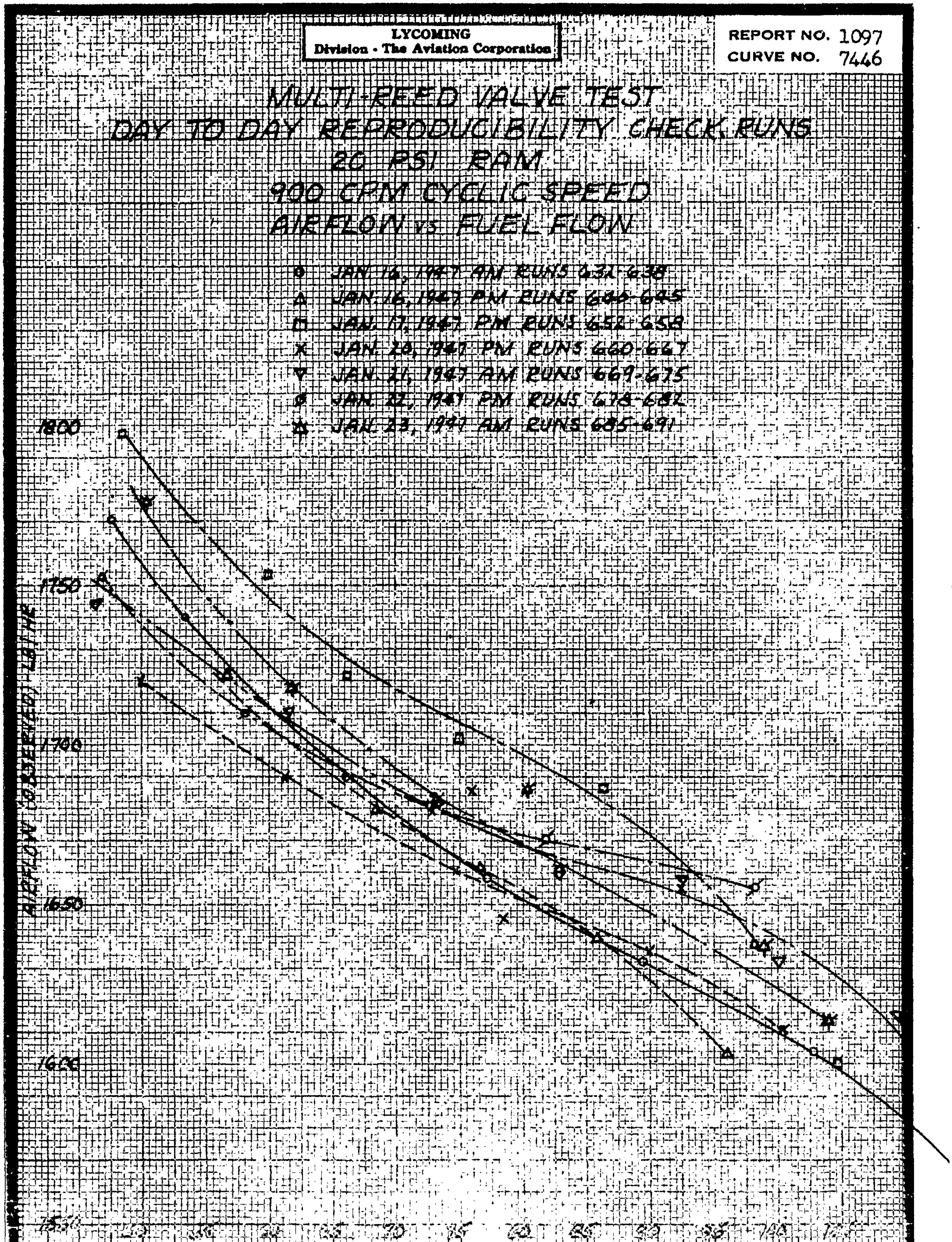
LYCOMING
Division - The Aviation Corporation

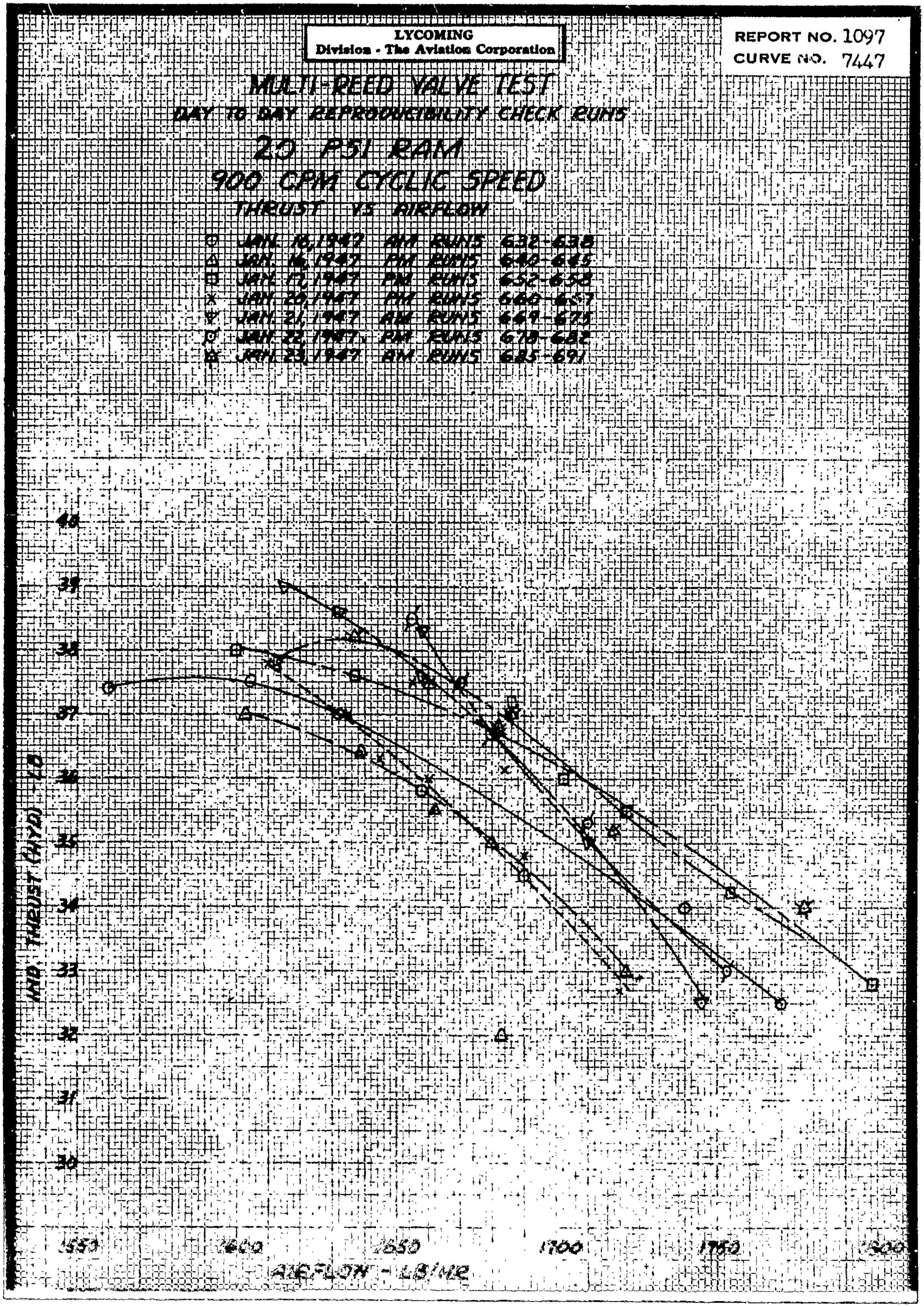
REPORT NO. 1097
CURVE NO. 7444

MULTI-REED VALVE TEST
25 PSI RAM
THRUST vs AIRFLOW



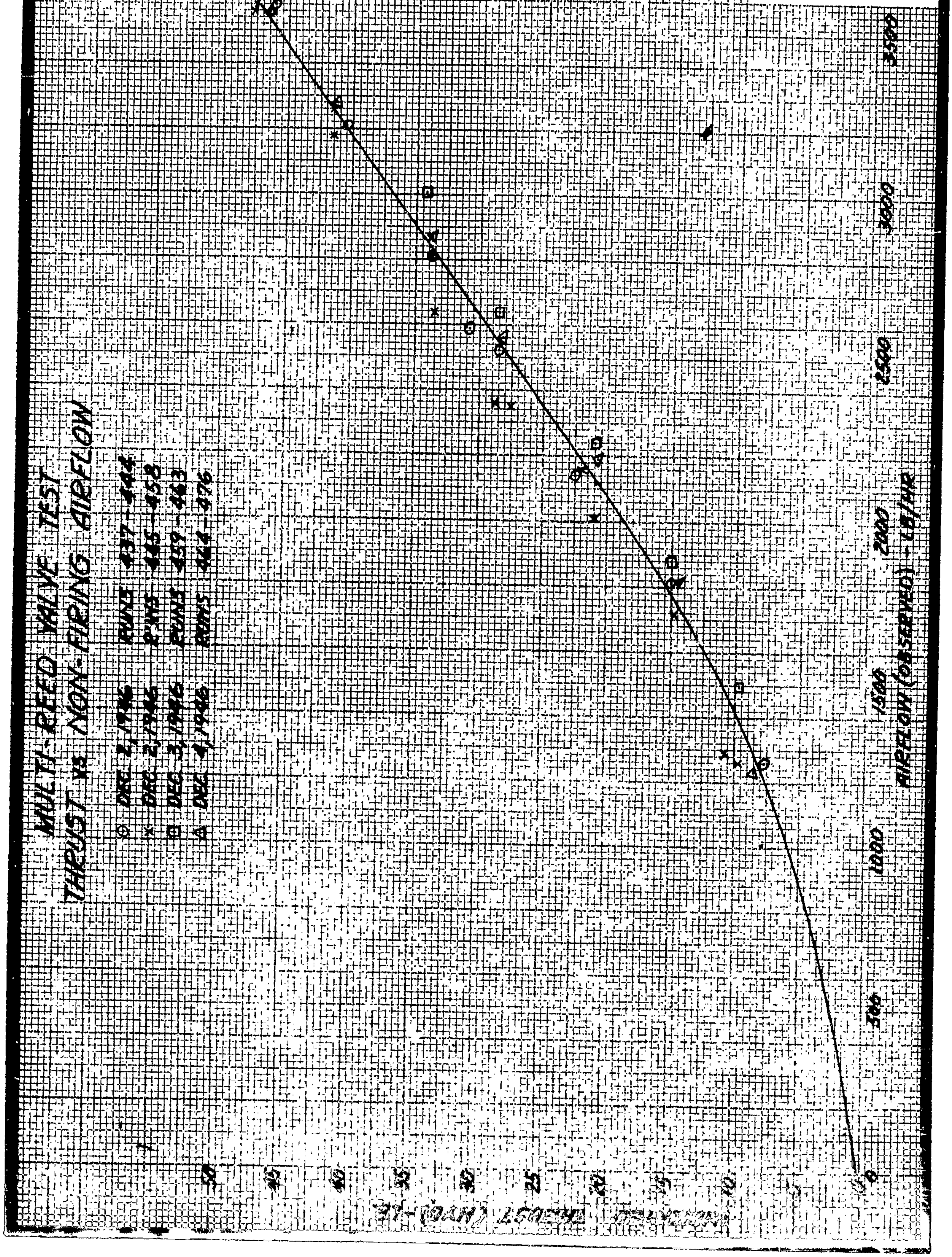


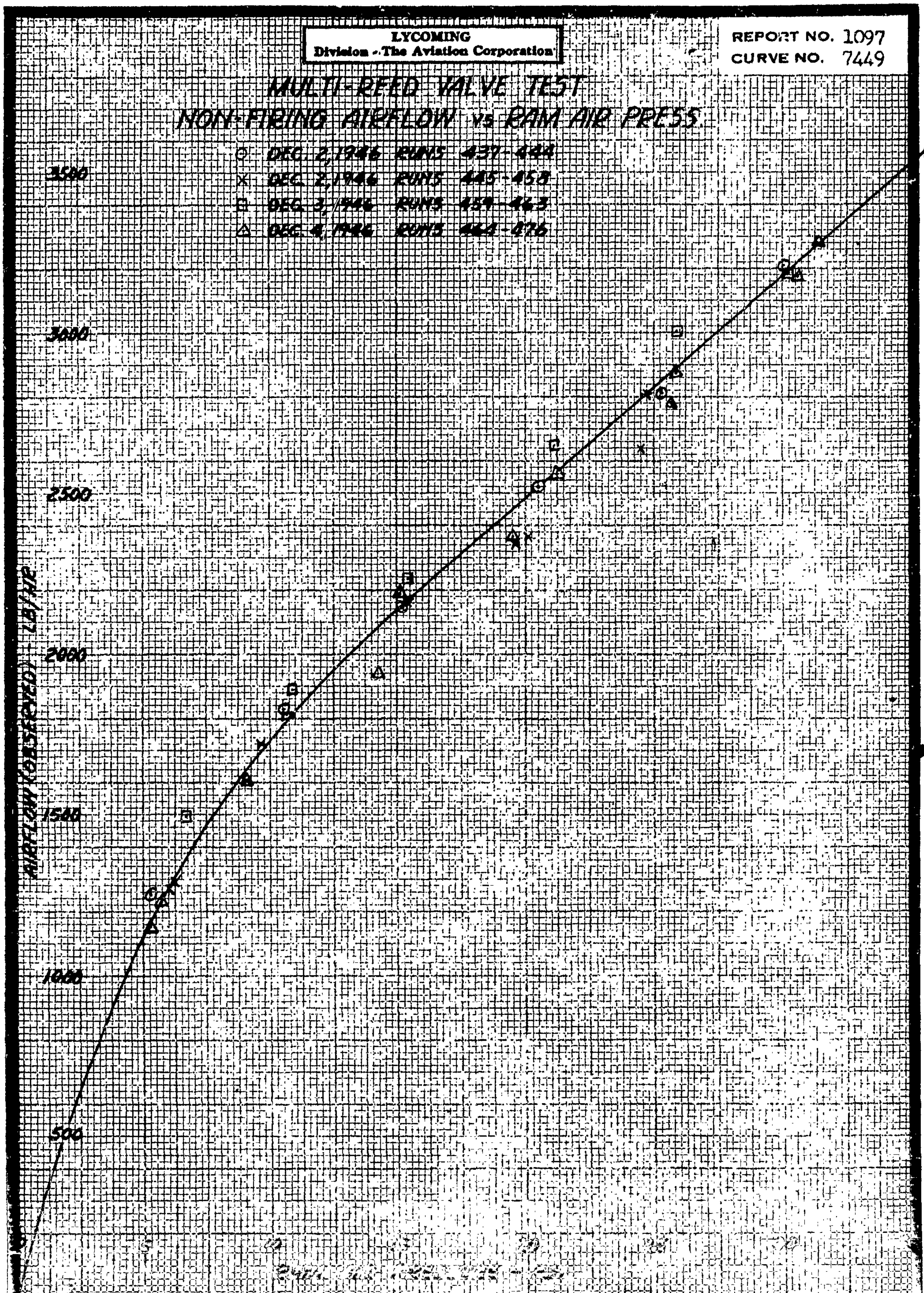

LYCOMING
Division - The Aviation Corporation
REPORT NO. 1097
CURVE NO. 7446
MULTI-REED VALVE TEST
DAY TO DAY REPRODUCIBILITY CHECK RUNS
20 PSI RAM
900 CPM CYCLIC SPEED
AIRFLOW vs FUEL FLOW
JAN. 16, 1947 AM RUNS 632-638
JAN. 16, 1947 PM RUNS 640-645
JAN. 17, 1947 PM RUNS 652-658
JAN. 20, 1947 PM RUNS 660-667
JAN. 21, 1947 AM RUNS 669-675
JAN. 22, 1947 PM RUNS 678-682
JAN. 23, 1947 AM RUNS 685-691
1800
1750
1700
1650
1600
AIRFLOW (OBSERVED) - LB/HR
FUEL FLOW - LB/HR


LYCOMING
Division - The Aviation Corporation
REPORT NO. 1097
CURVE NO. 7447
MULTI-REED VALVE TEST
DAY TO DAY REPRODUCIBILITY CHECK RUNS
20 PSI RAM
900 CPM CYCLIC SPEED
THRUST VS AIRFLOW
JAN. 16, 1947 AM RUNS 632-638
JAN. 16, 1947 PM RUNS 640-645
JAN. 17, 1947 PM RUNS 652-658
JAN. 20, 1947 PM RUNS 660-657
JAN. 21, 1947 AM RUNS 669-675
JAN. 22, 1947 PM RUNS 678-682
JAN. 23, 1947 AM RUNS 685-691
40
39
38
37
36
35
34
33
32
31
30
IND. THRUST (HYD) - LB
1550
1600
1650
1700
1750
1800
AIRFLOW - LB/HR

LYCOMING
Division - The Aviation Corporation

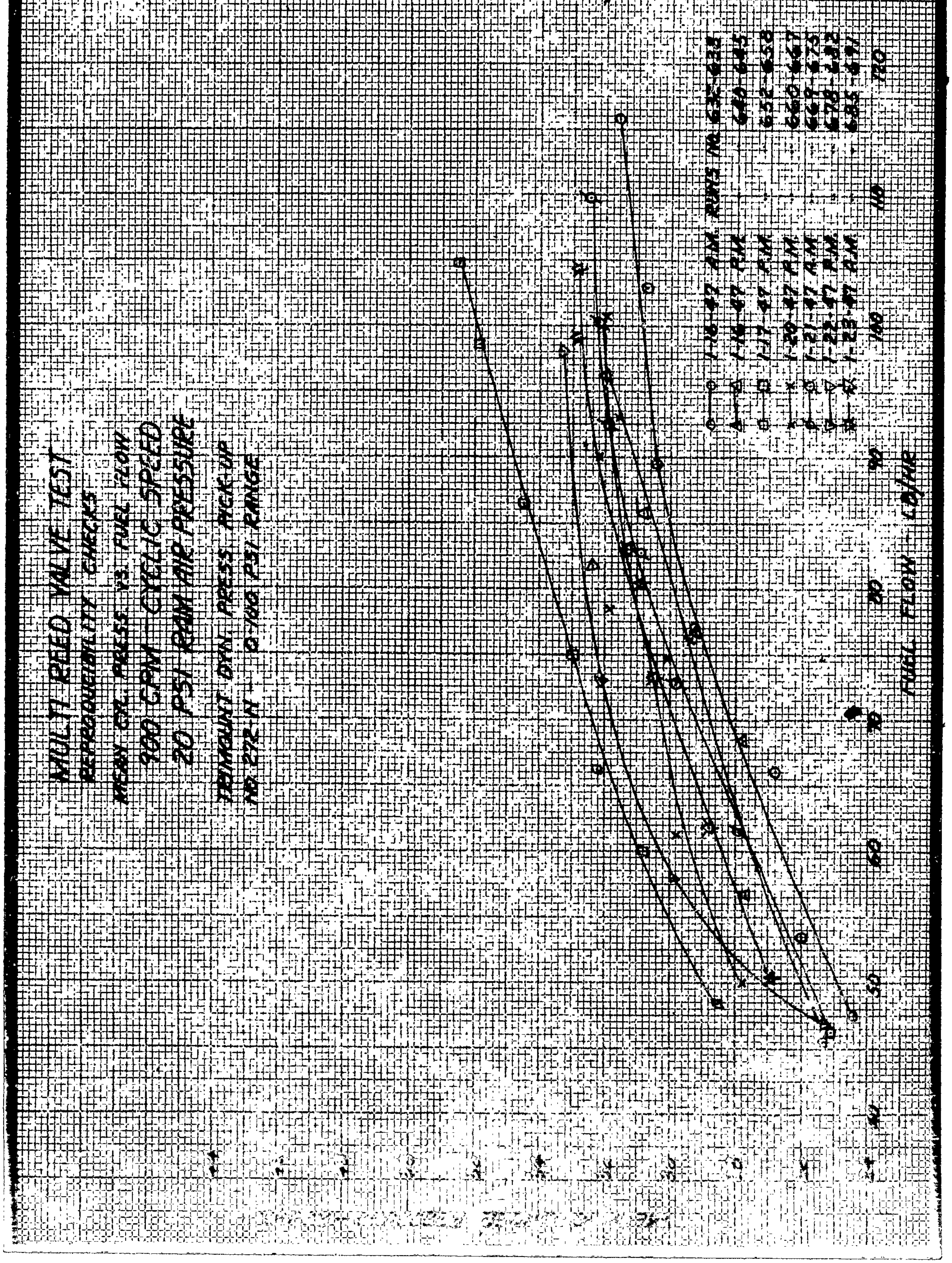
REPORT NO. 1097
CURVE NO. 7448




LYCOMING
Division - The Aviation Corporation
REPORT NO. 1097
CURVE NO. 7449
MULTI-REED VALVE TEST
NON-FIRING AIRFLOW vs RAM AIR PRESS.
DEC. 2, 1946 RUNS 437-444
DEC. 2, 1946 RUNS 445-458
DEC. 3, 1946 RUNS 459-463
DEC. 4, 1946 RUNS 464-476
3500
3000
2500
2000
1500
1000
500
AIRFLOW (OBSERVED) - LB/HR

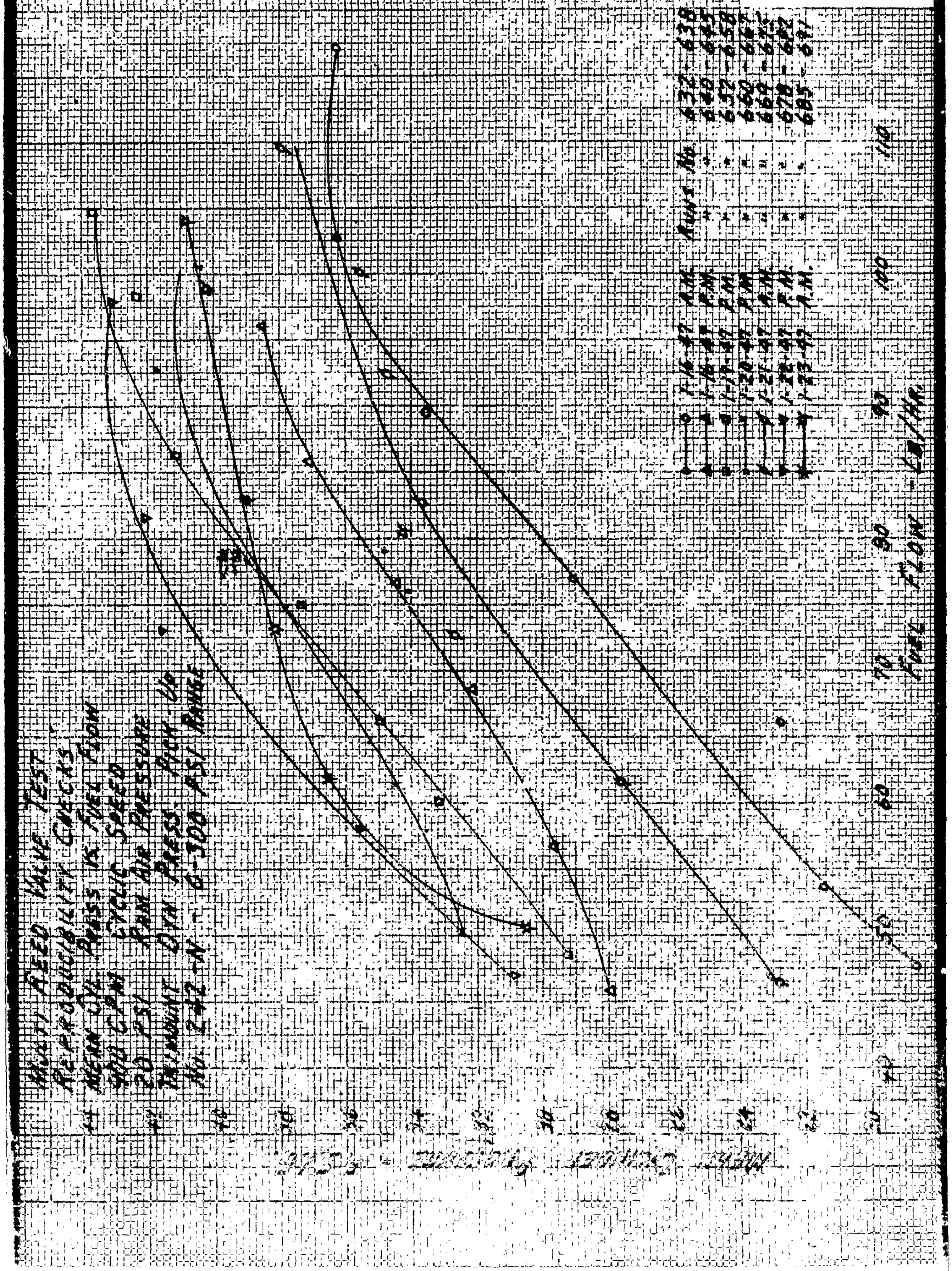
LYCOMING
Division - The Aviation Corporation

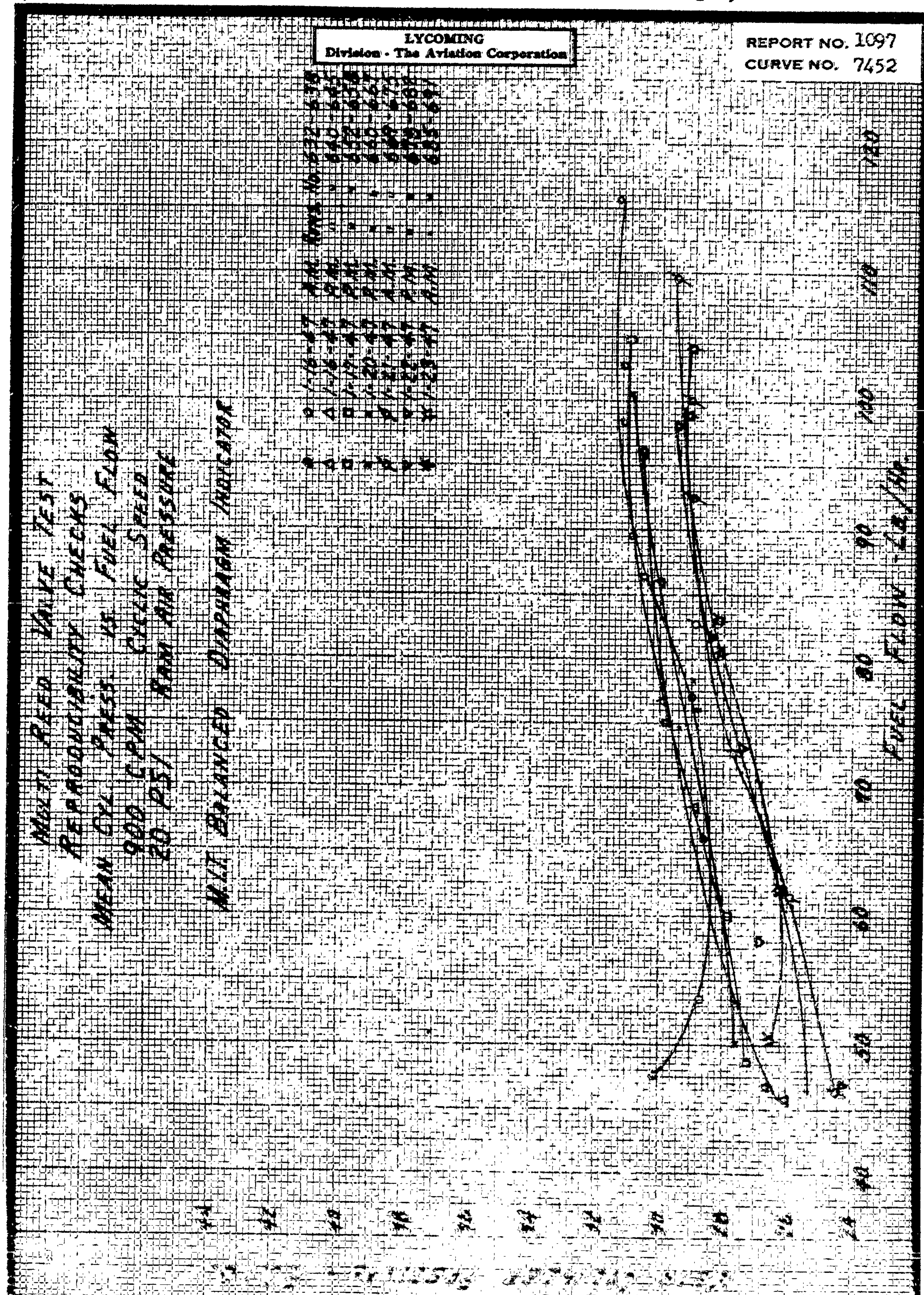
REPORT NO. 1097
CURVE NO. 7450



LYCOMING
Division - The Aviation Corporation

REPORT NO. 1097
CURVE NO. 7451

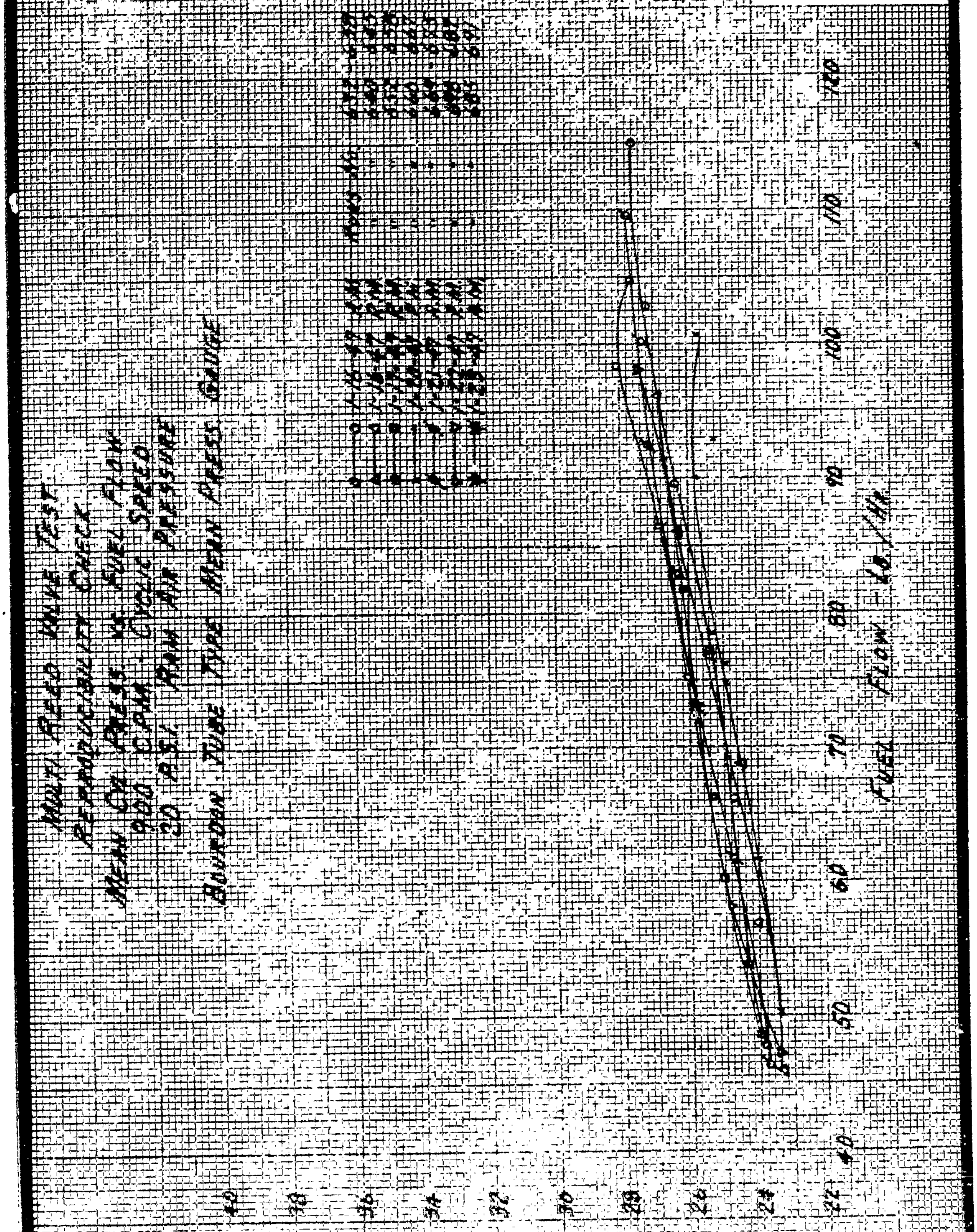


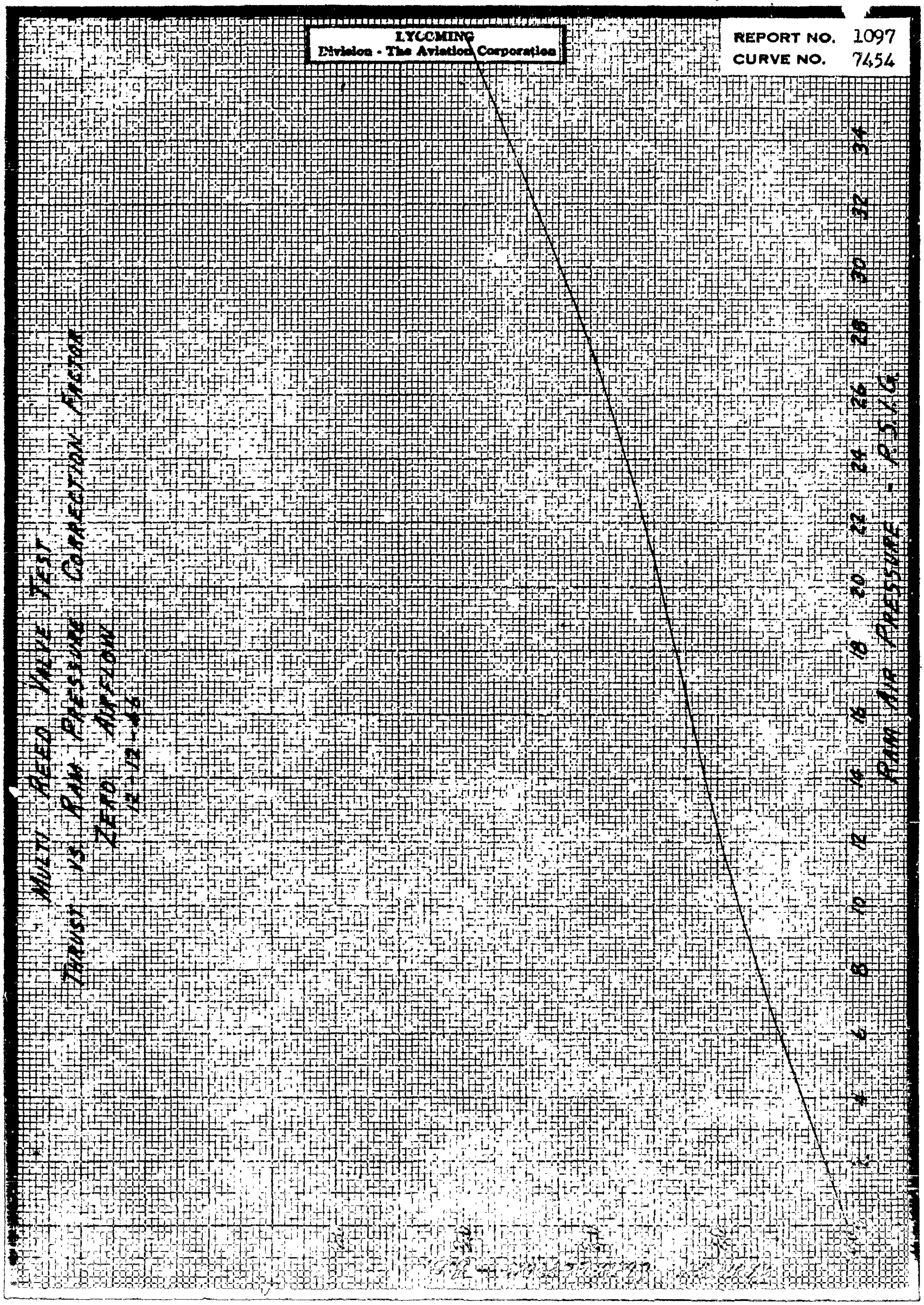

LYCOMING
Division - The Aviation Corporation
REPORT NO. 1097
CURVE NO. 7452
MULTI REED VALVE TEST
REPRODUCIBILITY CHECKS
MEAN CYL. PRESS. VS. FUEL FLOW
900 CPM CYCLIC SPEED
20 PSI RAM AIR PRESSURE
M.I.T. BALANCED DIAPHRAGM INDICATOR
40
50
60
70
80
90
100
110
120
FUEL FLOW - LB./HR.

Form-673

LYCOMING
Division - The Aviation Corporation

REPORT NO. 1097
CURVE NO. 7453




LYCOMING
Division - The Aviation Corporation
REPORT NO. 1097
CURVE NO. 7454
MULTI REED VALVE TEST
THRUST VS RAM PRESSURE CORRECTION FACTOR
ZERO AIRFLOW
12-12-46
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
RAM AIR PRESSURE - P.S.I.G.

FORM 874 28M-12-42

LYCOMING
DIVISION--THE AVIATION CORPORATION

REPORT NO. 1097

MULTI REED VALVE TEST

TABLE NO. 1

CYCLIC PRESSURE MEASURING INSTRUMENT COMPARISON ON AIR TEST FIXTURE

Remarks	Setting No.	Trimount Pick-up Ser. No. 272-N 100 psi. Range		Trimount Pick-up Ser. No. 271-N 50 psi. Range		M.I.T. Press.-Time Indicator Ser. No. 2		Mean Press. Gauge NA-3305-2	Cyclic Speed
		Mean	Peak	Mean	Peak	Mean	Peak	Mean	C.P.M.
160 psi. Test Fixture Air Supply Maintained	1	29.3	52.0	29.4	51.3	29.7	51.8	26.9	505
	2	34.3	44.0	34.6	45.7	35.0	47.2	33.1	1105
	3	33.7	44.2	33.8	45.5	34.0	46.1	32.6	1105
	4	27.8	50.5	28.8	50.8	29.0	51.8	26.8	501
	5	27.2	50.3	28.6	51.2	29.0	52.2	27.0	502
	6	31.7	43.8	32.0	44.7	32.5	45.6	30.7	1100
Drift			0.1		0.6				

Mean Pressure Comparison

Setting No.	100 psi. Pick-up		50 psi. Pick-up		Gauge		Speed
	Diff.	%Diff.	Diff.	%Diff.	Diff.	%Diff.	
1	-0.4	1.3	-0.3	1.0	-2.8	9.4	500
4	-1.2	4.1	-0.2	0.7	-2.2	7.6	
5	-1.8	6.2	-0.4	1.4	-2.0	6.9	
2	-0.7	2.0	-0.4	1.1	-1.9	5.4	1100
3	-0.3	2.5	-0.2	0.6	-1.4	4.1	
6	-0.8	0.9	-0.5	1.5	-1.8	5.5	

Peak Pressure Comparison

Setting No.	100 psi. Diff.	100 psi. %Diff.	50 psi. Diff.	50 psi. %Diff.	Gauge	Speed
1	0.2	0.4	-0.6	1.2		500
4	-1.3	2.5	-1.0	1.9		
5	-1.9	3.6	-1.0	1.9		
2	-3.2	6.8	-1.5	3.2		1100
3	-1.9	4.1	-0.6	1.3		
6	-1.8	3.9	-0.9	2.0		

Note:
All pressures psi.
No Correction for zero drift in Trimount pick-ups
Correction for M.I.T. pick-up diaphragm initial contact press. = 2.6 psi.

REPORT NO. 1097

LYCOMING
DIVISION--THE AVIATION CORPORATION

AERO PULSE LAB - S.O.D.

RESTRICTED

SUMMARY DATA SHEET

MULTI REED VALVE CHAMBER INITIAL TEST

SHEET No.	RUN No.	CYCLIC SPEED (C.P.M.)	RAM AIR PRESS. (P.S.I.G.)	FUEL FLOW (LB/HR)	AIRFLOW OBSERVED (LB/HR)	INDICATED THRUST (LB)	MEAN CHAMBER PRESS. (P.S.I.G.)			HEAT REJECTION (BTU/HR)	INLET MANIFOLD AIR TEMP (°F)	DATE
							BOURDON TUBE GAGE	WIANCKO PICK-UP 0-100 P.S.I. RANGE	M.I.T. INDICATOR			
85	517	493	15	34.8	1717	24.3				34,800	107	12-6
	518	493	15	37.7	1640	25.4				36,550	113	
86	519	497	15	62.5	1600	26.3				41,500	112	
	520	500	15	75.1	1572	27.2				41,500	112	
	521	505	15	69.8	1570	27.2				42,800	113	
89	534	595	15	33.8	1595	24.3				14,830	135	12-10
	536	595	15	35.4	1600	23.8				37,600	69	
	537	601	15	41.2	1573	24.8				44,050	92	
	538	604	15	45.6	1530	25.1				45,950	101	
	539	606	15	51.0	1507	25.5				44,000	109	
	540	604	15	50.5	1502	25.7				45,750	111	
90	541	607	15	57.4	1407	25.3				46,850	113	
	542	609	15	69.6	1273	24.5				48,400	113	
90	543	699	15	34.7	1533	24.5				45,350	116	12-10
	544	702	15	43.3	1507	25.7				51,400	117	
	545	703	15	52.6	1470	26.2				51,600	117	
	546	705	15	55.3	1440	25.9				55,000	117	
91	548	800	15	34.8	1580	27.2				49,200	110	12-11
	549	795	15	42.1	1533	27.7				53,100	112	
	550	806	15	50.5	1489	28.9				61,350	115	
	551	802	15	49.9	1490	28.8				62,050	120	
92	552	804	15	49.3	1542	27.2				59,350	96	
	553	806	15	55.5	1493	29.4				59,000	107	
	554	813	15	62.7	1462	30.0				64,550	115	
	555	815	15	73.3	1423	30.4				73,900	133	
	556	798	15	66.0	1037	22.8				65,050	127	
											C.K.	2-3-47

NO. 6025S TRACING   A. B. K. ELLIOTT CO., PITTSBURGH

LYCOMING
DIVISION–THE AVIATION CORPORATION

REPORT NO. 1097

AERO PULSE LAB. - S.O.D.

RESTRICTED

SUMMARY DATA SHEET

MULTI REED VALVE CHAMBER INITIAL TEST

SHEET No.	RUN No.	CYCLIC SPEED (C.P.M.)	RAM AIR PRESS. (P.S.I.G.)	FUEL FLOW (LB/HR)	AIRFLOW OBSERVED (LB/HR)	INDICATED THRUST (LB.)	MEAN CHAMBER PRESS. (P.S.I.G.) BOURDON TUBE GAGE	WIANCKO PICK-UP 0-100 P.S.I. RANGE	M.I.T. INDICATOR	HEAT REJECTION (BTU/HR)	INLET MANIFOLD AIR TEMP. (°F)	DATE
92	557	906	15	35.9	1517	36.1				51,450	130	12-11
	558	907	15	40.0	1500	27.9				54,450	130	
	559	908	15	54.5	1460	29.5				64,000	133	
	560	900	15	67.7	1402	30.3				74,200	135	
93	561	902	15	74.0	1380	30.4				73,500	137	
	562	911	15	85.0	1335	31.6				76,600	137	
	563	893	15	91.5	1017	23.4				74,000	137	
93	564	997	15	43.4	1488	28.4				61,500	137	12-II
	565	998	15	51.6	1448	29.8				60,000	137	
	566	1002	15	62.7	1368	30.4				63,450	137	
	567	1008	15	78.5	1333	31.4				63,900	137	
	568	995	15	88.5	1323	31.9				68,600	138	
	569	1000	15	96.0	1250	32.3				70,600	139	
94	570	993	15	99.5	1008	24.0				63,500	140	
94	571	1111	15	53.4	1343	29.2				63,500	134	12-II
	572	1100	15	64.4	1332	30.7				69,200	133	
	573	1102	15	77.3	1285	31.0				78,500	133	
	574	1106	15	83.5	1263	31.4				79,750	132	
	575	1112	15	97.6	1218	31.9				81,000	132	
	576	1098	15	103.6	1200	32.3				84,100	130	
	577	1106	15	115.0	1147	31.1				76,600	130	
95	578	1206	15	49.3	1350	28.4				61,900	130	12-II
	579	1211	15	63.4	1250	30.1				63,800	128	
	580	1198	15	72.3	1238	30.9				73,500	129	
	581	1303	15	83.2	1218	31.2				74,900	123	
	582	1212	15	103.4	1163	30.7				77,700	129	
	583	1200	15	115.0	1156	30.7				77,900	130	
	584	1205	15	131.3	1133	29.[illegible]				69,100	128	

CHL 5-3-47

LYCOMING
DIVISION--THE AVIATION CORPORATION

REPORT NO. 1097

AERO PULSE LAB - S.O.D.

RESTRICTED

SUMMARY DATA SHEET

MULTI REED VALVE CHAMBER INITIAL TEST

SHEET No.	RUN No.	CYCLIC SPEED (C.P.M.)	RAM AIR PRESS. (P.S.I.G.)	FUEL FLOW (LB/HR)	AIRFLOW OBSERVED (LB/HR)	INDICATED THRUST (LB)	MEAN CHAMBER PRESS. (P.S.I.G.) BOURDON TUBE GAGE	TRIMOUNT PICK-UP 0-100 PSI RANGE	M.I.T. INDICATOR	HEAT REJECTION (BTU/HR)	INLET MANIFOLD AIR TEMP (°F)	DATE
60	352	507	20	24.7	1970	31.3		23.7		25,450	142	11-21
	353	511	20	35.4	1940	33.0		24.7		25,100	145	
61	354	504	20	39.5	1960	32.6		33.1		15,350	63	11-22
	356	493	20	34.6	1952	32.5		23.9		21,400	86	
	357	500	20	49.4	1908	33.7		24.8		24,000	94	
	359	506	20	49.6	1890	33.7		24.9		26,100	110	
	361	501	20	49.3	1870	34.4		25.4		27,900	113	
	362	502	20	58.8	1840	35.1		25.6		27,000	109	
62	363	501	20	57.4	1835	35.1		25.9		26,700	111	
	364	506	20	71.5	1820	35.7		25.9		27,150	112	
	365	507	20	103.7	1795	35.9		26.1		27,150	114	
	366	510	20	113.2	1713	36.5		26.6		25,950	115	
62	367	596	20	36.9	1850	33.4		25.6		25,500	115	11-22
	368	599	20	45.8	1830	34.1		25.6		41,700	115	
	370	597	20	42.5	1820	34.1		25.1		42,500	120	
	371	599	20	43.2	1807	34.1		35.6		45,900	120	
63	373	602	20	51.5	1775	35.2		26.4		47,400	122	
	374	601	20	51.6	1793	35.2		26.6		47,400	122	
	375	603	20	62.9	1738	36.0		26.9		47,400	121	
	376	603	20	90.0	1680	36.3		26.9		49,000	120	
	377	604	20	99.1	1563	36.5		27.1		49,700	120	
64	379	706	20	54.5	1700	33.3		34.6		61,000	110	11-2
	380	708	20	62.1	1535	33.5		35.4		63,900	120	
	381	708	20	64.7	1470	32.5		35.6		64,500	122	
	382	713	20	103.7	1304	31.4		34.1		61,500	125	
68	407	703	20	36.8	1830	32.0		24.7		56,100	95	11-2
	408	707	20	46.2	1795	34.0		35.0		59,400	102	
	409	710	20	54.0	1760	35.0		36.4		62,000	110	
	410	702	20	57.3	1700	34.0		36.3		59,600	113	

C/L

FORM 674 20M-12-48

REPORT NO. 1097

LYCOMING
DIVISION–THE AVIATION CORPORATION

AERO PULSE LAB. - S.O.D.

RESTRICTED

SUMMARY DATA SHEET

MULTI REED VALVE CHAMBER INITIAL TEST

SHEET No.	RUN No.	CYCLIC SPEED (CPM)	RAM AIR PRESS. (P.S.I.G.)	FUEL FLOW (LB/HR)	AIRFLOW OBSERVED (LB/HR)	INDICATED THRUST (LB)	MEAN CHAMBER PRESS. (P.S.I.G.) BOURDON TUBE GAGE	THRUST PICK-UP 0-100 PSI RANGE	M.I.T. INDICATOR	HEAT REJECTION (BTU/HR)	INLET MANIFOLD AIR TEMP. (°F)	DATE
68	411	701	20	65.4	1466	33.0		24.7		63,800	116	11-2
	412	700	20	55.0	1710	34.6		26.9		59,700	131	
42	228	801	20	41.7	1814	33.2				33,750	136	10-2
	229	803	20	49.5	1797	34.9				40,500	136	
43	230	807	20	57.9	1808	36.7				47,200	138	
	231	809	20	68.0	1772	39.0				64,300	138	
	232	813	20	76.3	1737	39.4				81,100	138	
	233	800	20	86.2	1698	36.4				82,600	138	
43	234	909	20	54.2	1737	36.1				75,800	138	10-2
	235	905	20	54.9	1793	36.1				72,000	100	
	236	916	20	65.9	1758	36.9				77,000	110	
	237	905	20	76.1	1753	38.2				88,200	112	
44	238	911	20	86.2	1680	38.6				88,700	117	
	239	914	20	87.0	1676	39.1				93,100	120	
	240	900	20	97.2	1672	33.6				90,600	121	
	241	900	20	97.2	1629	38.8				88,700	123	
	242	917	20	130.0	1230	30.3				96,300	123	
45	246	995	20	56.7	1717	37.0				77,800	141	10-2
	247	998	20	74.0	1679	38.0				85,500	142	
	249	1006	20	85.5	1612	39.6				92,000	148	
	250	1000	20	74.9	1628	37.7				93,600	149	
46	251	1007	20	93.1	1566	40.1				92,500	151	
	252	1010	20	99.1	1545	41.0				95,000	151	
	253	1015	20	108.0	1513	41.4				93,300	150	
	256	995	20	112.0	1488	40.0				90,750	155	
46	257	1089	20	65.6	1575	37.2				84,100	153	10-2
	258	1114	20	82.5	1518	39.4				80,300	153	

C.L. [illegible]

FORM 874 20M-12-42

REPORT NO. 1097

LYCOMING
DIVISION--THE AVIATION CORPORATION

AERO PULSE LAB. - S.O.D.

RESTRICTED

SUMMARY DATA SHEET

MULTI REED VALVE CHAMBER INITIAL TEST

SHEET No.	RUN No.	CYCLIC SPEED (C.P.M.)	RAM AIR PRESS. (P.S.I.G.)	FUEL FLOW (LB/HR)	AIRFLOW OBSERVED (LB/HR)	INDICATED THRUST (LB)	MEAN CHAMBER PRESS. (P.S.I.G.) BOURDON TUBE GAGE	PIRAMOUNT PICK-UP 0-100 P.S.I. RANGE	M.I.T. INDICATOR	HEAT REJECTION (BTU/HR)	INLET MANIFOLD AIR TEMP. (°F)	DATE
47	359	1095	20	86.2	1531	41.4				94,000	152	10-2
	360	1095	20	91.4	1511	40.3				97,100	152	
	261	1098	20	100.8	1490	40.4				97,100	152	
	262	1102	20	107.0	1486	40.6				97,500	152	
47	363	1232	20	127.7	1313	38.7				86,100	152	10-2

NO. 5028 TRACING PA. A. K. ELLIOTT CO., PITTSBURGH

FORM 674 25M-12-42

REPORT NO. 1097

LYCOMING
DIVISION--THE AVIATION CORPORATION

AERO PULSE LAB. - S.O.D.

RESTRICTED

SUMMARY DATA SHEET

MULTI REED VALVE CHAMBER INITIAL TEST

SHEET No.	RUN No.	CYCLIC SPEED (C.P.M.)	RAM AIR PRESS. (P.S.I.G.)	FUEL FLOW (LB/HR)	AIRFLOW OBSERVED (LB/HR)	INDICATED THRUST (LB)	MEAN CHAMBER PRESS. (P.S.I.G.) BOURDON TUBE GAGE	WIANCKO PICK-UP 0-100 PSI RANGE	M.I.T. INDICATOR	HEAT REJECTION (BTU/HR)	INLET MANIFOLD AIR TEMP (°F)	DATE
18	98	500	25	31.2	2270	37.8				38,700	165	9-18
	99	497	25	37.3	2233	38.0				51,500	173	
	100	497	25	47.7	2140	38.5				53,800	175	
	101	498	25	62.5	2060	39.8				56,000	177	
84	505	509	25	43.3	2220	38.1				38,550	90	12-6
	507	501	25	49.1	2300	38.6				46,300	105	
	508	505	25	55.8	2320	39.4				49,450	113	
	509	513	25	65.3	2160	40.0				54,000	123	
	510	497	25	85.5	2140	39.8				49,000	126	
85	511	499	25	75.3	2135	39.4				48,200	127	
	512	500	25	75.1	2125	39.4				45,800	128	
	513	492	25	43.8	2185	37.7				48,000	125	
	514	492	25	52.0	2140	38.6				46,600	127	
	515	494	25	65.6	2115	39.4				47,950	131	
47	266	592	25	37.6	2305	40.6				44,400	129	10-2
	267	588	25	36.3	2247	40.8				50,100	133	
48	268	599	25	37.2	2230	41.4				50,150	139	
	269	600	25	39.4	2213	41.6				55,300	142	
	270	601	25	46.3	2185	43.2				56,100	145	
	271	602	25	52.4	2123	43.8				56,600	149	
	272	606	25	63.2	2120	44.1				58,350	149	
	273	609	25	72.4	2063	44.4				63,050	153	
	274	610	25	80.4	2019	44.9				63,050	155	
49	276	700	25	41.0	2142	40.0				64,600	157	10-29
	277	703	25	49.0	2090	41.4				65,300	150	
	278	710	25	60.5	2025	42.0				64,700	158	
	279	712	25	67.4	1940	41.0				66,500	158	
	280	706	25	74.5	1922	41.8				65,400	161	
	281	704	25	76.7	1855	42.2				5[illegible],300	163	

FORM 674 50M-12-43

LYCOMING
DIVISION--THE AVIATION CORPORATION

REPORT NO. 1097

AERO PULSE LAB. - S.O.D.

RESTRICTED

SUMMARY DATA SHEET

MULTI REED VALVE CHAMBER INITIAL TEST

SHEET No.	RUN No.	CYCLIC SPEED (C.P.M.)	RAM AIR PRESS. (P.S.I.G.)	FUEL FLOW (LB/HR)	AIRFLOW OBSERVED (LB/HR)	INDICATED THRUST (LB.)	MEAN CHAMBER PRESS. (P.S.I.G.) BOURDON TUBE GAGE	PIMOUNT PICK-UP 0-100 PSI RANGE	M.I.T. INDICATOR	HEAT REJECTION (BTU/HR)	INLET MANIFOLD AIR TEMP (°F)	DATE
49	283	711	25	90.4	1853	42.2				71,600	164	
54	307	804	25	43.4	2270	41.6				63,100	143	11-1
	308	813	25	57.4	2245	43.6				81,500	142	
	309	816	25	70.0	2320	44.9				87,700	144	
55	310	808	25	82.3	2200	44.9				84,300	147	
	311	809	25	94.0	2175	45.4				83,400	146	
	312	809	25	95.8	2158	46.1				89,200	145	
55	313	900	25	57.3	2290	44.0				78,700	144	11-1
	314	902	25	69.5	2345	45.6				89,400	142	
	315	903	25	77.1	2220	46.7				95,200	144	
	316	907	25	84.2	2303	47.7				101,000	145	
	317	907	25	86.5	2175	48.0				101,000	145	
	318	908	25	97.5	2140	47.3				106,000	146	
68	414	1000	25	59.9	1922	45.0				75,550	134	11-2
69	415	1004	25	73.5	1952	47.3				100,300	130	
	416	1008	25	79.5	1892	48.4				101,800	130	
	417	1010	25	87.2	1887	49.3				105,300	130	
	418	1012	25	94.1	1868	50.1				117,400	125	
	419	1020	25	107.8	1820	51.0				114,400	125	
	420	1002	25	105.7	1812	50.4				111,800	133	
	421	1003	25	107.5	1317	50.8				116,200	131	
70	424	1106	25	82.5	1755	46.1				117,500	125	11-2
	425	1101	25	100.9	1792	46.1				111,200	122	
	427	1100	25	121.1	1763	49.3				111,700	120	
	428	1108	25	113.6	1698	49.8				115,000	120	
	429	1100	25	109.8	1738	49.3				112,300	133	

C/L 3-9-4?

NO. 90288 TRACING PA K. ELLIOTT CO., PITTSBURGH

FORM 874 20M-12-43

LYCOMING
DIVISION—THE AVIATION CORPORATION

REPORT NO. 1097

AERO PULSE LAB. - S.O.D.
RESTRICTED

SUMMARY DATA SHEET

MULTI REED VALVE CHAMBER INITIAL TEST

SHEET No.	RUN No.	CYCLIC SPEED (C.P.M.)	RAM AIR PRESS. (P.S.I.G.)	FUEL FLOW (LB/HR)	AIRFLOW ~~OBSERVED~~ (LB/HR)	INDICATED THRUST (LB)	MEAN CHAMBER PRESS. (P.S.I.G.) BOURDON TUBE GAGE	THRUST PICK-UP 0-100 P.S.I. RANGE	M.I.T. INDICATOR	HEAT REJECTION (BTU/HR)	INLET MANIFOLD AIR TEMP. (°F)	DATE
109	632	905	20	47.5	1770	32.5	23.8	24.4	30.1	66,000	77	1-16
	633	896	20	53.5	1740	34.0	24.3	26.0	28.7	68,500	88	
	634	900	20	66.0	1690	34.5	24.7	26.8	28.6	76,300	94	
	635	905	20	77.0	1658	35.8	25.4	29.2	29.0	79,200	100	
	636	907	20	89.5	1632	37.0	26.4	30.4	30.9	83,500	105	
	637	914	20	102.9	1604	37.5	27.2	31.7	31.2	83,100	107	
	638	907	20	115.8	1560	37.4	27.3	31.6	31.4	80,700	108	
110	640	890	20	45.6	1683	32.0	23.3	25.3	26.0	65,800	67	
	641	900	20	46.7	1722	33.0	24.0	27.7	26.6	75,100	112	
	642	903	20	68.5	1680	35.0	24.5	27.8	28.9	76,700	115	
	643	907	20	76.8	1662	35.5	25.4	25.3	29.9	83,900	117	
	644	909	20	85.9	1639	36.4	26.3	27.7	30.0	83,100	117	
	645	900	20	96.2	1603	37.0	26.9	27.8	30.6	86,500	119	
112	652	896	20	48.5	1798	32.8	24.0	28.5	27.2	55,400	91	1-17
	653	901	20	60.0	1754	34.2	25.0	30.8	27.8	76,400	97	
113	654	903	20	66.1	1722	35.5	25.3	32.2	28.7	82,000	100	
	655	892	20	75.0	1702	36.0	26.0	33.0	29.8	81,300	103	
	656	892	20	86.3	1686	37.4	26.9	34.5	30.5	86,000	107	
	657	909	20	98.3	1637	37.6	28.1	35.9	31.1	91,400	108	
	658	901	20	104.8	1600	38.0	27.7	36.5	31.0	91,700	108	
114	660	897	20	50.0	1720	33.7	23.4	27.8	27.6	53,500	83	1-20
	661	897	20	61.4	1690	34.8	24.0	29.8	28.1	70,900	98	
	662	906	20	74.7	1660	36.0	24.9	30.1	29.4	[illegible]0,400	112	
	663	897	20	78.4	1645	36.3	25.3	31.9	29.0	83,500	133	
	664	902	20	90.0	1635	37.0	25.8	33.2	.	73,000	131	
115	665	895	20	76.0	1684	36.3	24.9	29.4	28.8	122,000	99	
	666	903	20	93.8	1655	37.5	25.2	31.6	30.5	134,800	103	
	667	896	20	100.6	1610	37.8	25.7	33.0	31.0	139,500	107	
116	669	904	20	46.3	1745	32.5	23.7	25.1	24.4	59,100	90	1-[illegible]
	670	909	20	61.5	1710	35.0	24.7	37.9	35.9	70,300	93	
	671	904	20	73.7	1681	36.7	25.8	39.8	37.7	77,500	98	

[illegible]

FORM 874 2010-12-42

LYCOMING
DIVISION–THE AVIATION CORPORATION

REPORT NO. 1097

AERO PULSE LAB. - S.O.D.

RESTRICTED

SUMMARY DATA SHEET

MULTI REED VALVE CHAMBER INITIAL TEST

SHEET No.	RUN No.	CYCLIC SPEED (C.P.M.)	RAM AIR PRESS. (P.S.I.G.)	FUEL FLOW (LB/HR)	AIRFLOW OBSERVED (LB/HR)	INDICATED THRUST (LB.)	MEAN CHAMBER PRESS. (P.S.I.G.) BOURDON TUBE GAGE	WIANCKO PICK-UP 0-100 P.S.I. RANGE	M.I.T. INDICATOR	HEAT REJECTION (BTU/HR.)	INLET MANIFOLD AIR TEMP. (°F)	DATE
116	672	897	20	82.8	1658	37.6	26.3	30.9	28.9	87,000	102	1-21
	673	900	20	93.5	1658	38.3	27.2	31.9	29.0	88,700	104	
	674	900	20	100.2	1632	38.6	27.4	32.3	29.1	91,500	104	
	675	903	20	109.7	1615	39.0	27.8	32.5	29.6	91,600	105	
118	678	897	20	46.8	1753	33.0	23.4	25.3	24.3	65,500	60	1-22
	679	905	20	58.0	1710	35.3	24.8	29.9	26.8	74,400	76	
	680	895	20	73.0	1680	36.7	25.8	32.1	27.4	93,200	84	
	681	900	20	81.7	1670	37.5	26.2	32.4	28.4	92,200	90	
	682	907	20	98.2	1655	38.5	27.5	33.3	29.5	100,000	92	
120	685	898	20	50.4	1777	33.2	24.4	26.9	26.5	63,400	53	1-23
	686	890	20	61.8	1718	33.5	24.8	28.8	26.3	79,200	73	
	687	904	20	73.2	1683	35.0	25.9	30.5	27.6	78,700	83	
	688	903	20	83.0	1660	35.8	26.5	31.3	28.3	78,150	94	
	689	902	20	80.5	1686	35.0	23.7	30.9	28.1	94,900	78	
121	690	910	20	93.0	1637	36.5	27.6	32.9	29.2	91,050	92	
	691	895	20	104.1	1613	36.0	27.5	32.9	29.1	91,200	100	

NO. 0000 TRACING PAPER G. H. ELLIOTT CO., PITTSBURGH

LYCOMING
DIVISION--THE AVIATION CORPORATION

REPORT NO. 1097

AERO PULSE LAB. - S.O.D.

RESTRICTED

SUMMARY DATA SHEET

MULTI REED VALVE CHAMBER INITIAL TEST

SHEET No.	RUN No.	CYCLIC SPEED (C.P.M.)	RAM AIR PRESS. (P.S.I.G.)	FUEL FLOW (LB/HR)	AIRFLOW OBSERVED (LB/HR)	INDICATED THRUST (LB)	MEAN CHAMBER PRESS. (P.S.I.G.) BOURDON TUBE GAGE	PRIMOUNT PICK-UP 0-100 PSI RANGE	M.I.T. INDICATOR	HEAT REJECTION (BTU/HR)	INLET MANIFOLD AIR TEMP. (°F)	DATE
73	437	----	5.3	----	1258	7.6					43	12-2
	438		10.65		1815	15.0					53	
	439		15.2		2142	25.6					69	
	440		20.6		2520	28.5					88	
	441		25.3		2815	33.7					90	
	442		30.1		3210	40.5					98	
	443		35.5		3580	46.0					103	
	444		23.65		2590	30.8					104	
74	445		6.1		1262	9.8					51	
	446		9.7		1720	14.7					58	
	447		15.35		2160	22.0					67	
	448		19.7		2350	27.5					73	
	449		24.85		2815	33.5					80	
	450		30.55		3261	41.5					82	
	451		35.7		3580	47.5					91	
75	452		35.75		3563	47.7					107	
	453		30.2		3180	41.6					110	
	454		24.47		2639	33.5					111	
	455		20.1		2360	28.8					110	
	456		13.6		2002	21.0					110	
	457		6.2		1295	10.7					108	
	458		0.0		0000	0.8					---	
76	459		6.7		1498	9.7					45	12-3
	460		10.9		1883	15.0					69	
	461		15.4		2238	21.0					84	
	462		21.2		3645	28.4					92	
	463		25.8		3003	34.3					99	
77	464		5.8		1237	8.5					55	12-4
	465		10.7		1318	14.6					63	
	466		15.5		2193	2[illegible].9					78	
	467		21.3		2560	28.2					30	
											C/L	[illegible]

FORM 474

REPORT NO. 1097

LYCOMING
DIVISION—THE AVIATION CORPORATION

AERO PULSE LAB. - S.O.D.

RESTRICTED

SUMMARY DATA SHEET

MULTI REED VALVE CHAMBER INITIAL TEST

SHEET No.	RUN No.	CYCLIC SPEED (C.P.M.)	RAM AIR PRESS. (P.S.I.G.)	FUEL FLOW (LB/HR)	AIRFLOW OBSERVED (LB/HR)	INDICATED THRUST (LB)	MEAN CHAMBER PRESS. (P.S.I.G.) BOURDON TUBE GAGE	TRIMOUNT PICK-UP 0-100 P.S.I. RANGE	M.I.T. INDICATOR	HEAT REJECTION (BTU/HR)	INLET MANIFOLD AIR TEMP (°F)	DATE
77	468	----	25.8	----	2870	33.6					97	12-4
	469		31.3		3280	41.2					102	
	470		35.6		3565	46.5					108	
78	471		30.6		3178	41.0					118	
	472		25.7		2780	35.0					121	
	473		19.5		2367	26.8					120	
	474		14.3		1940	20.6					120	
	475		9.2		1602	14.0					116	
	476		5.3		1157	8.3					113	

NO. 80828 TRACING A. J. E. ELLIOTT CO., PITTSBURGH

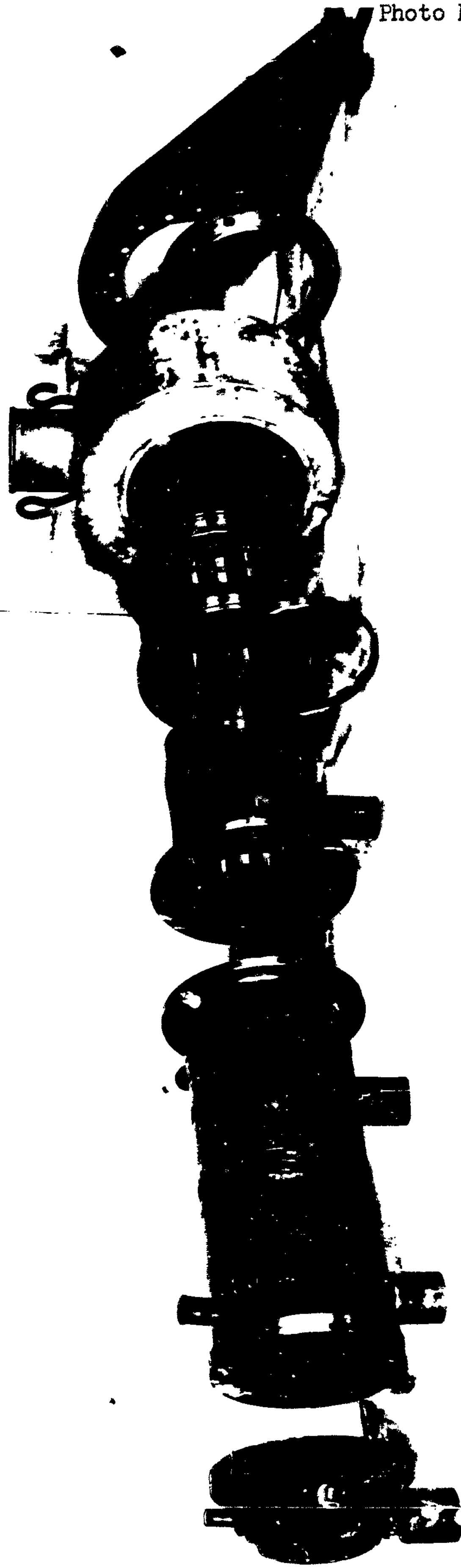
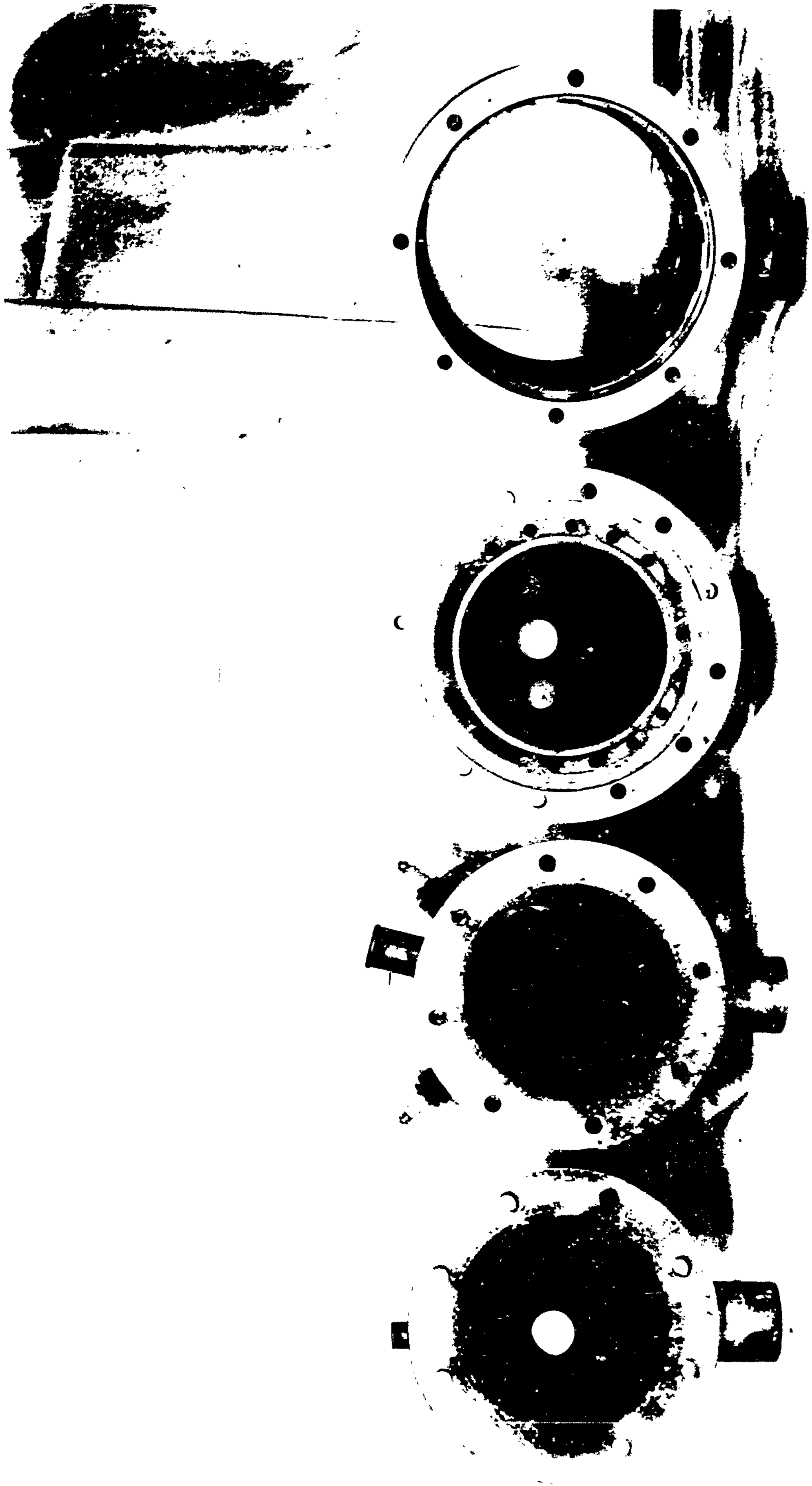
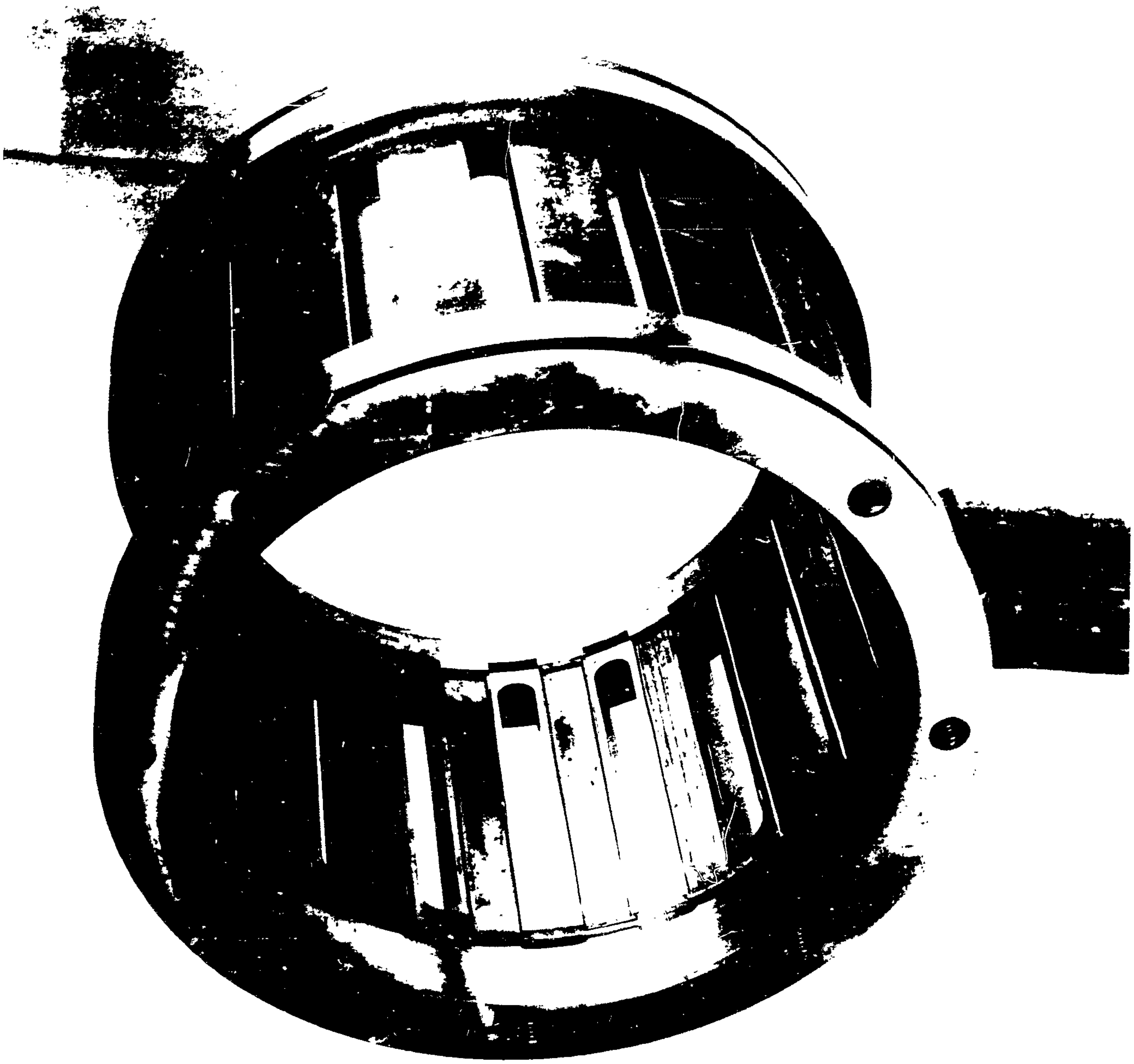
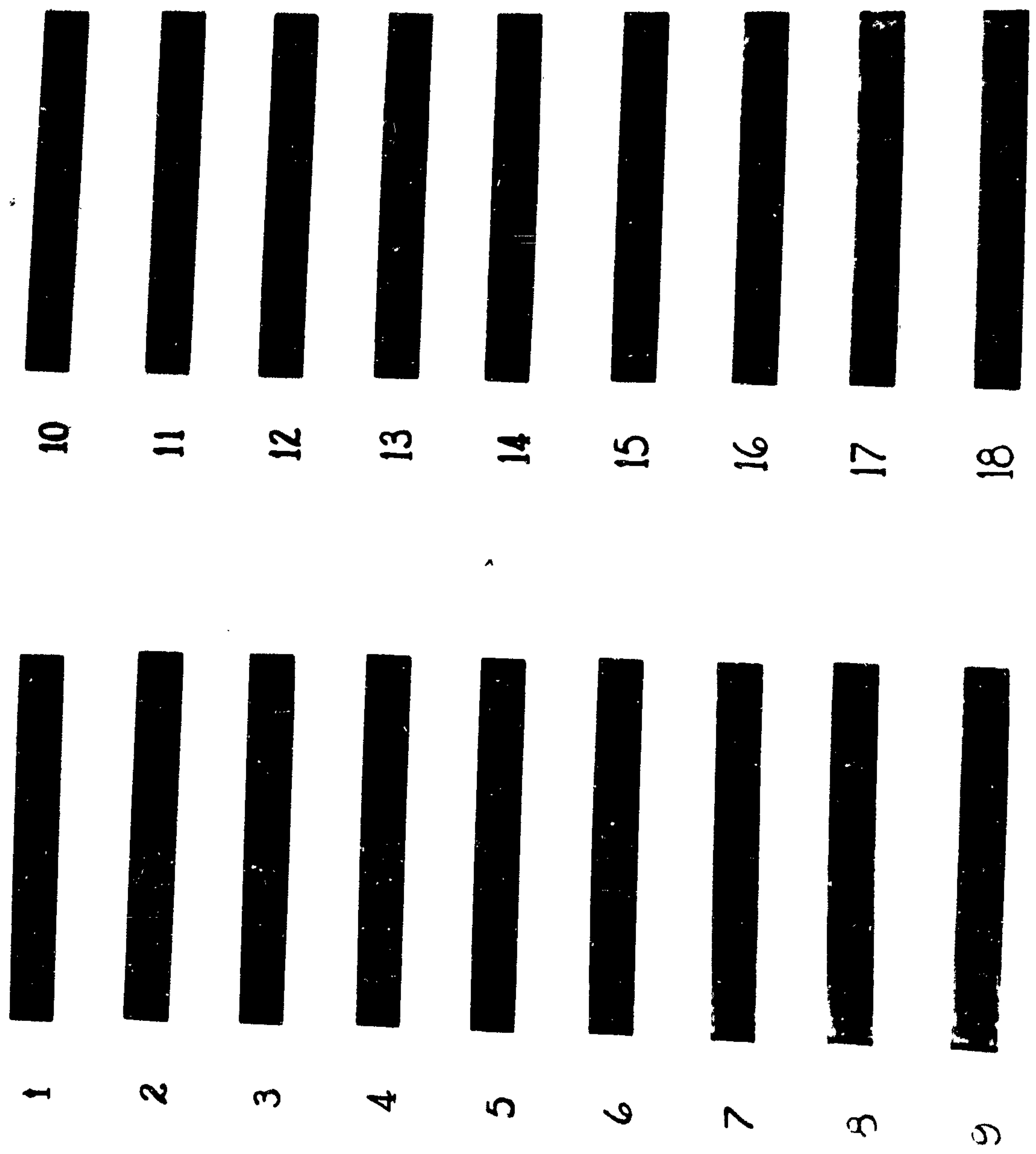


Photo E-4496



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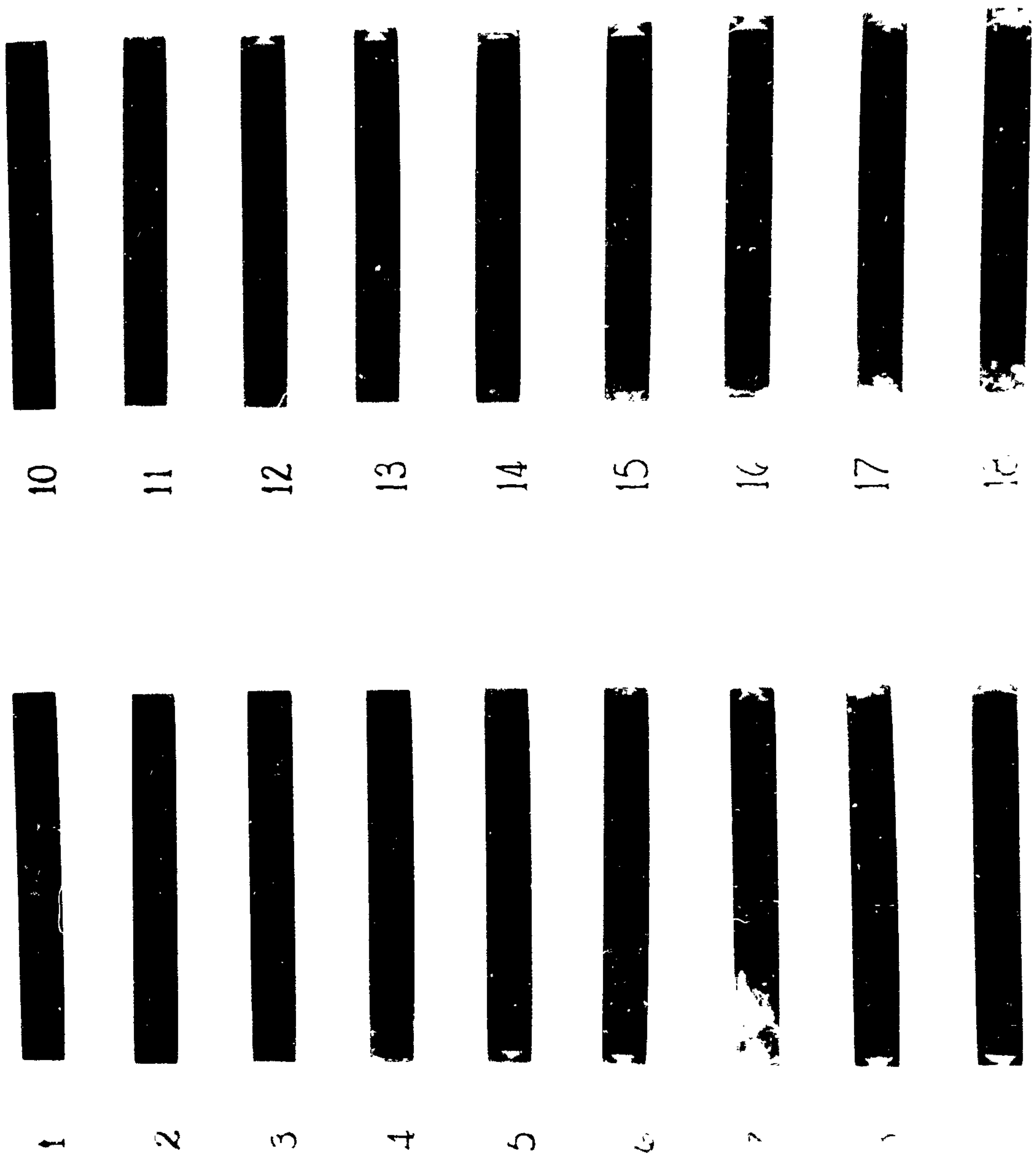
1 2 3 4 5 6 7 8 9



Figures 631 & 632

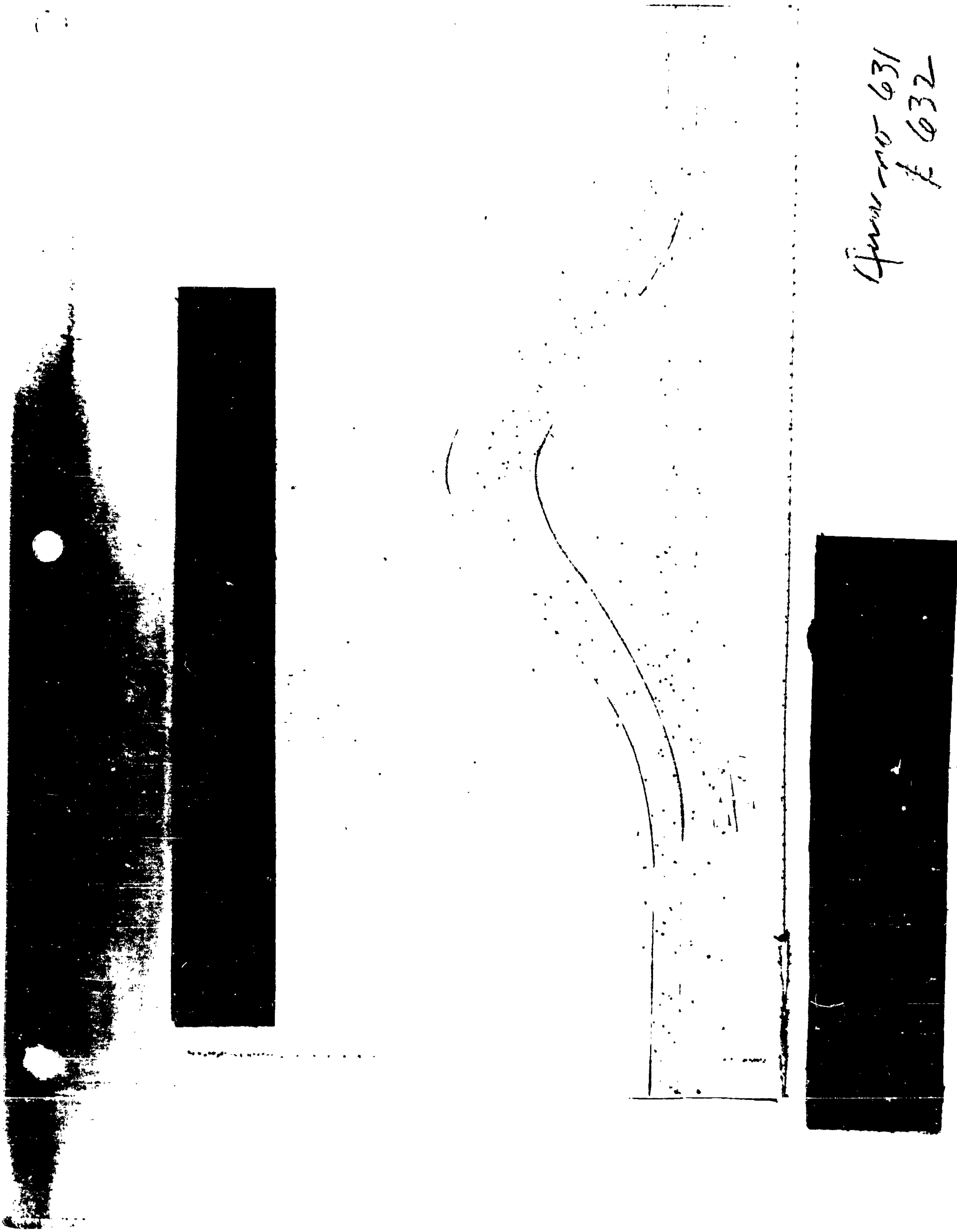
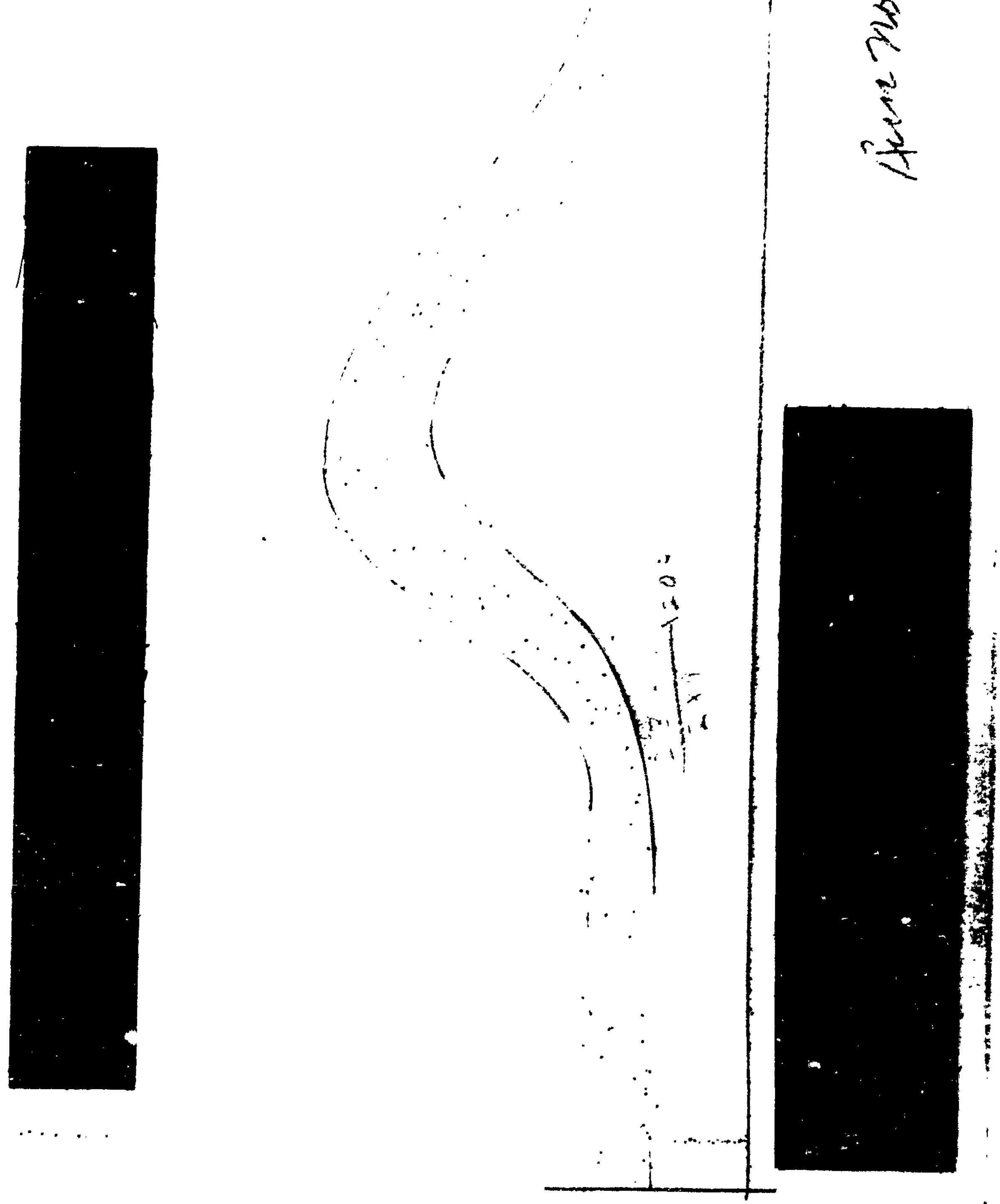
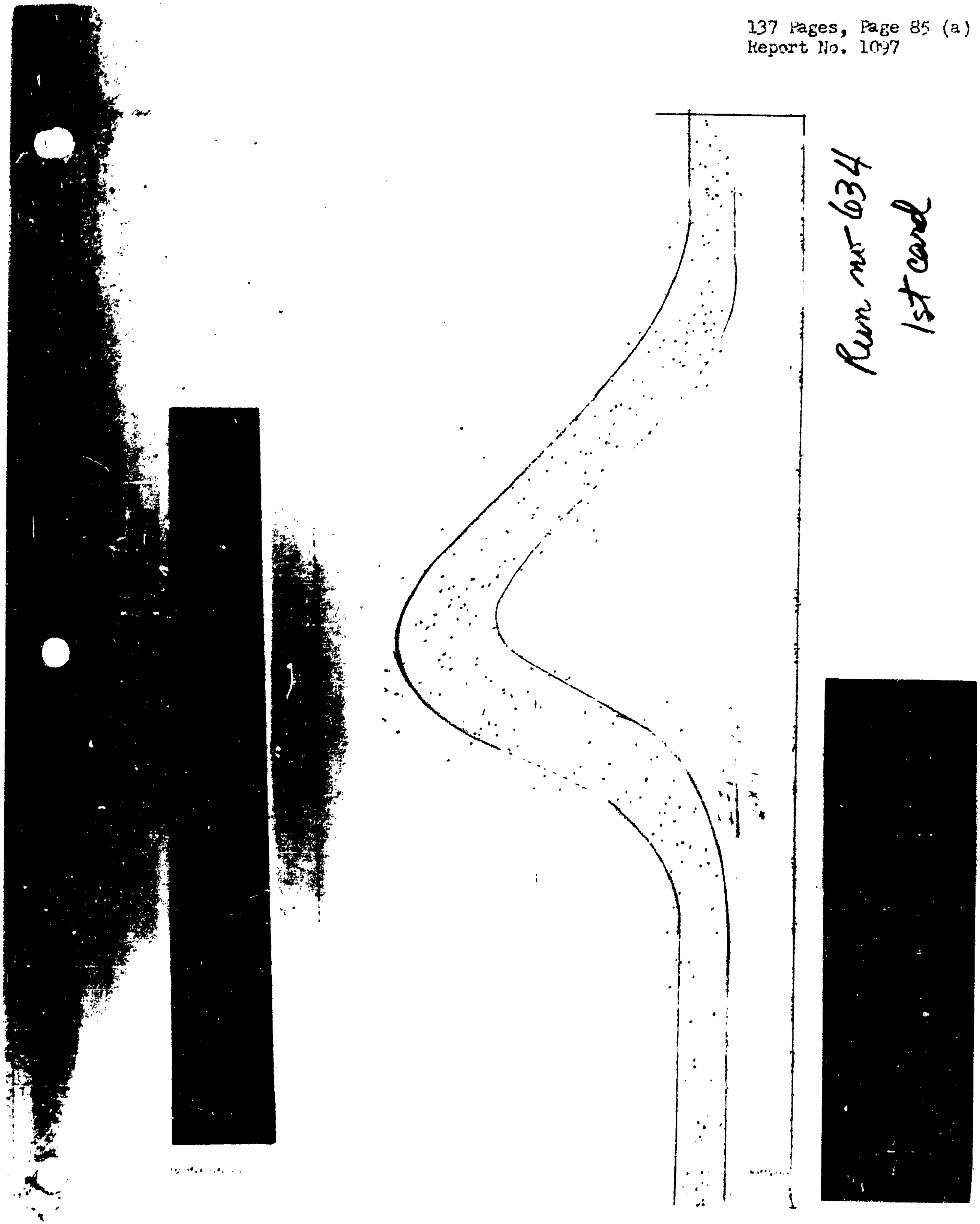


Figure No 633

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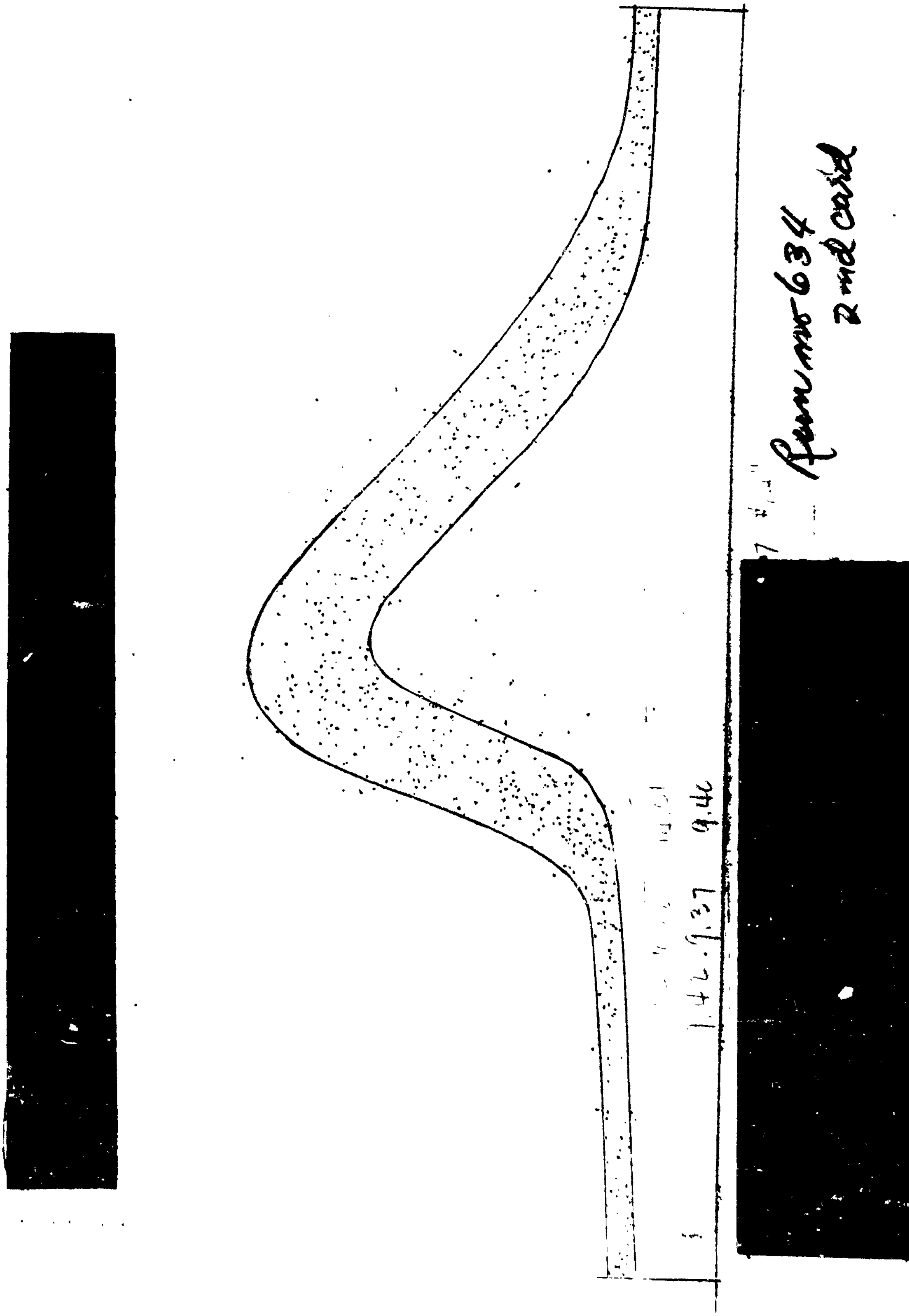
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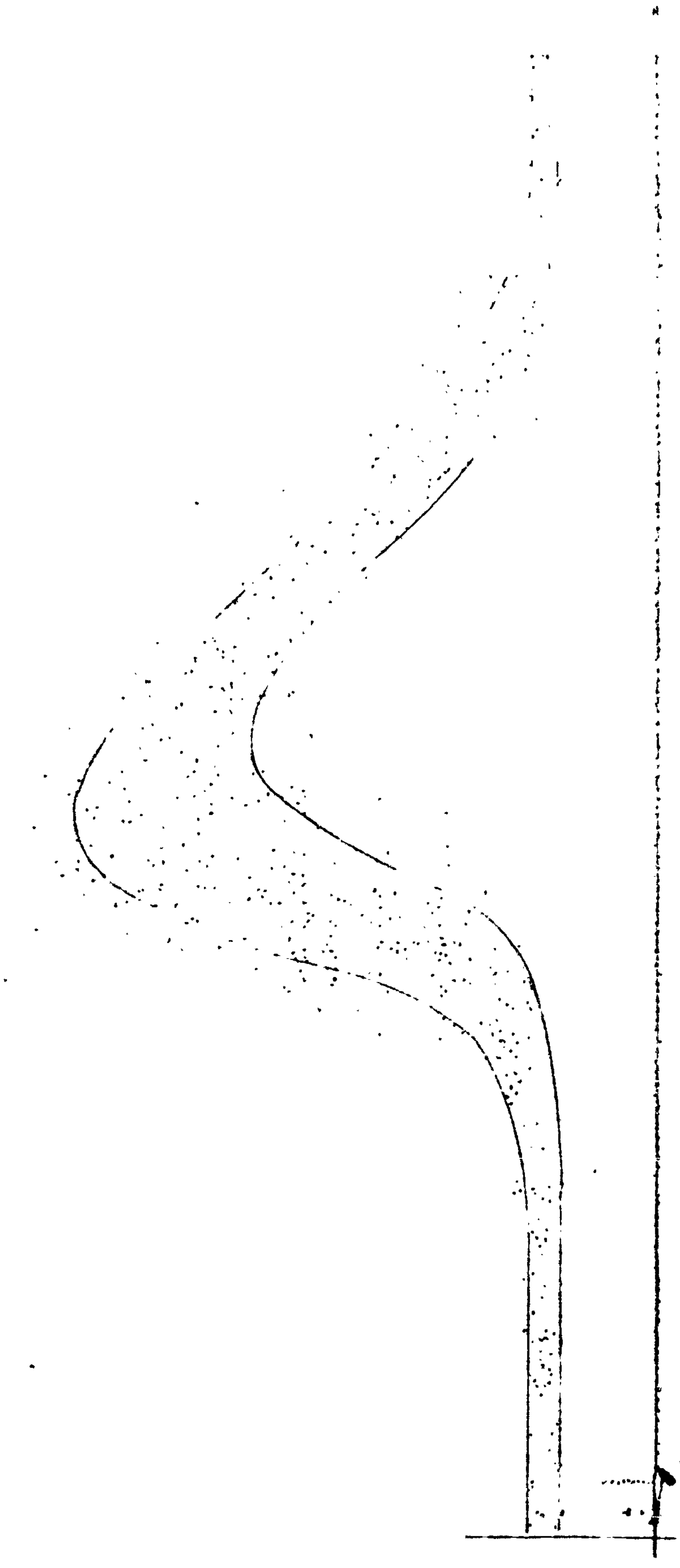

Figure 37

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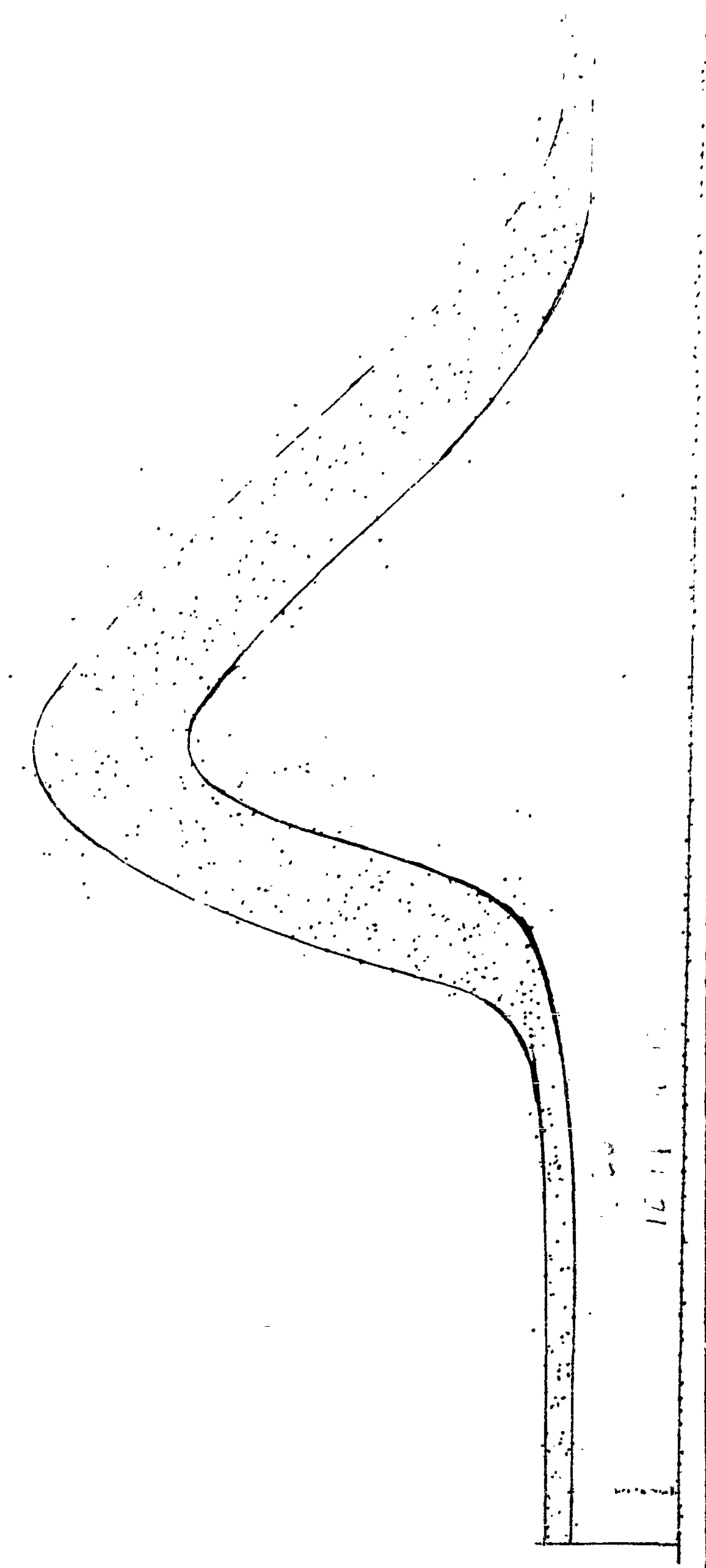

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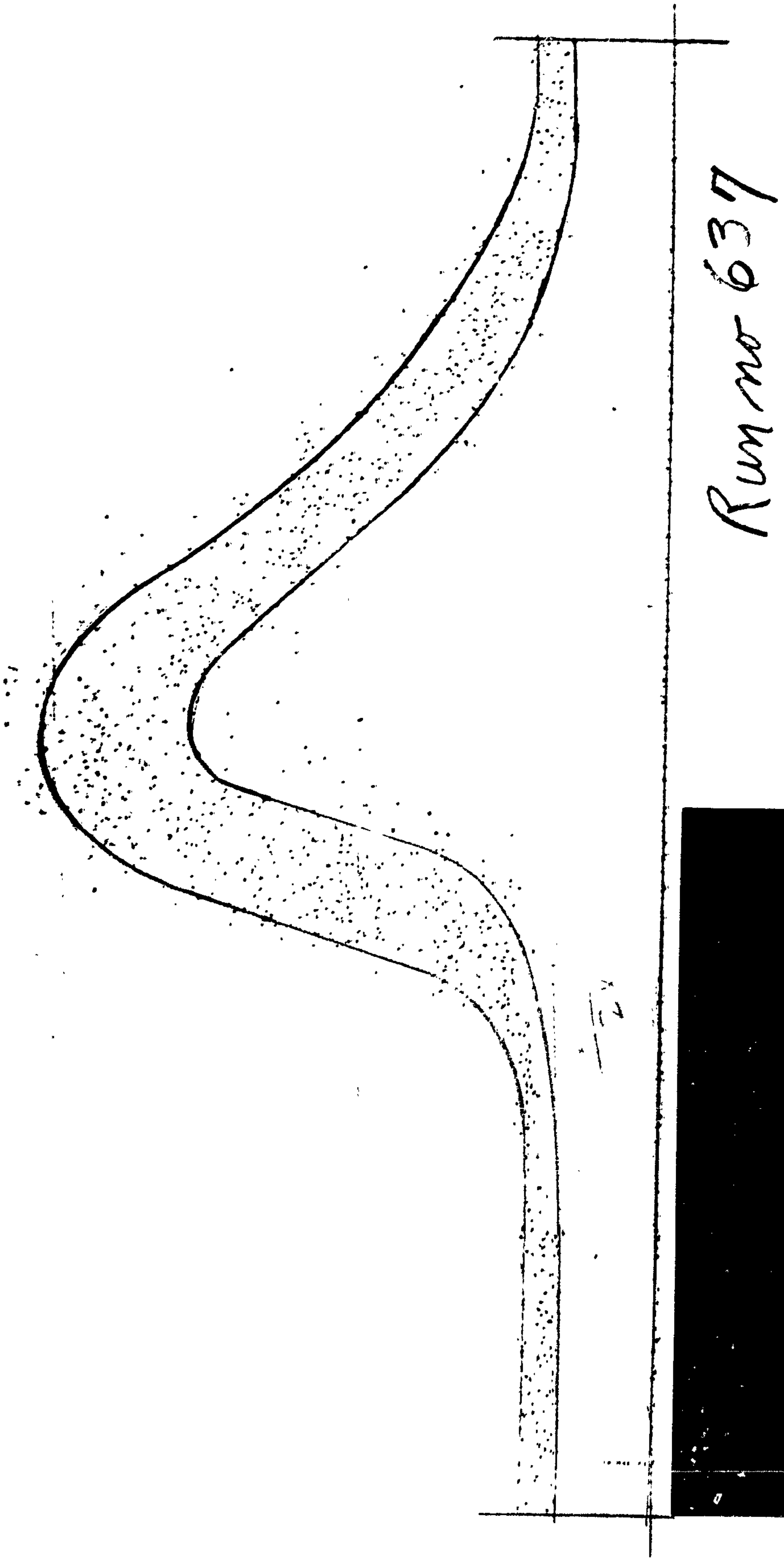

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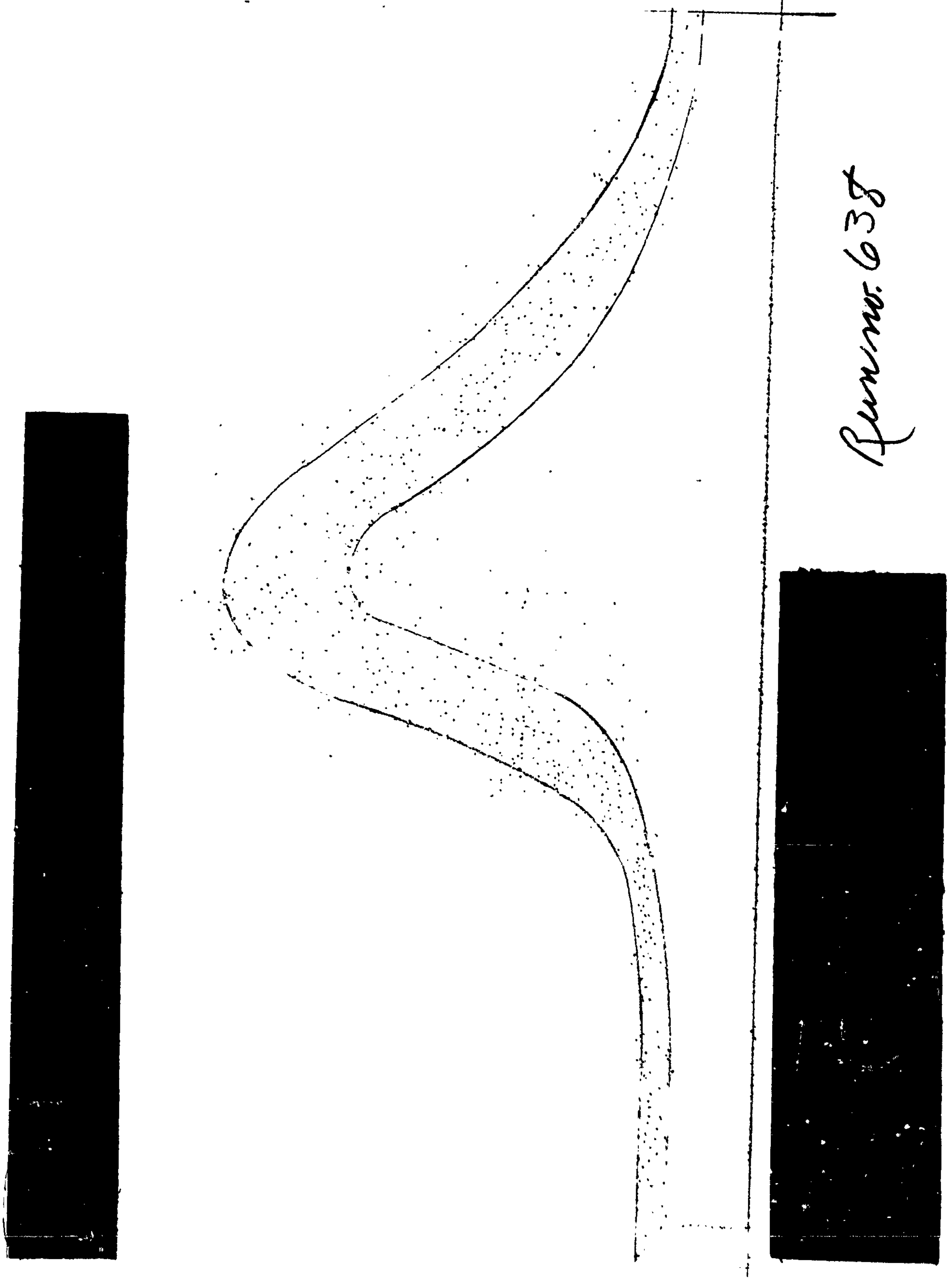
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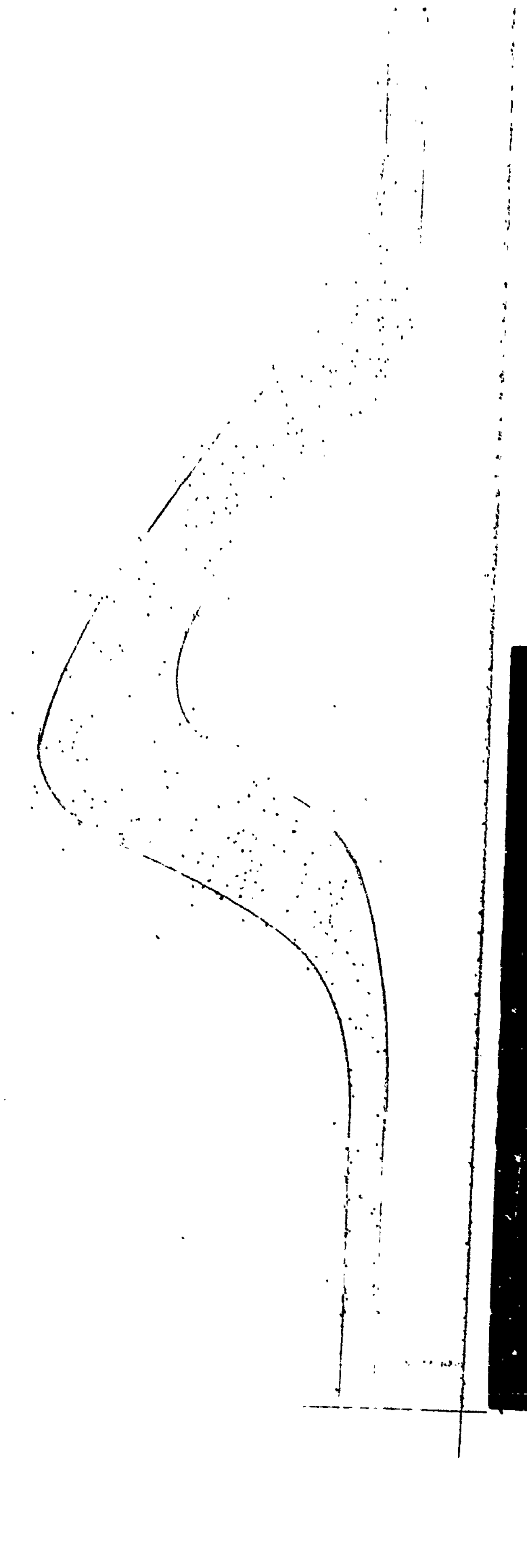

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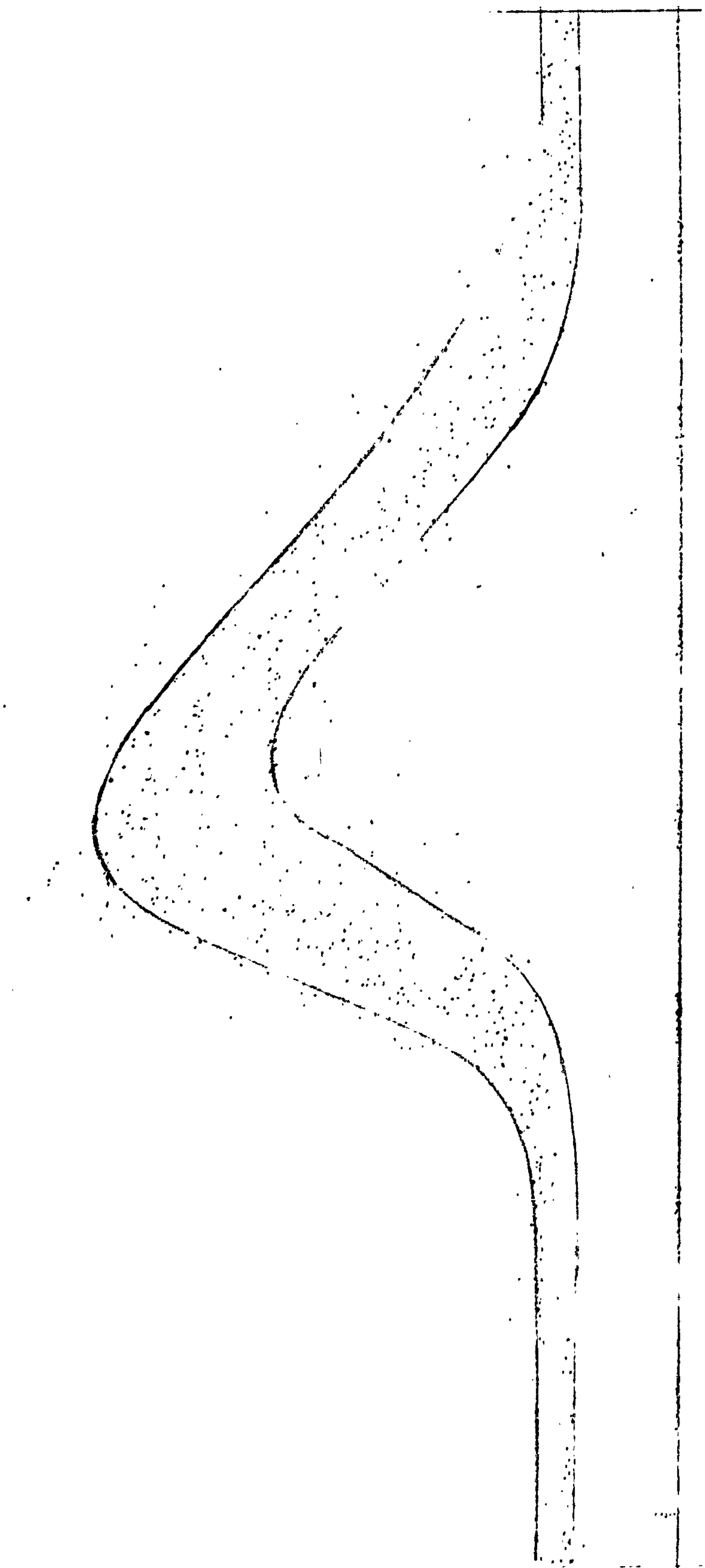

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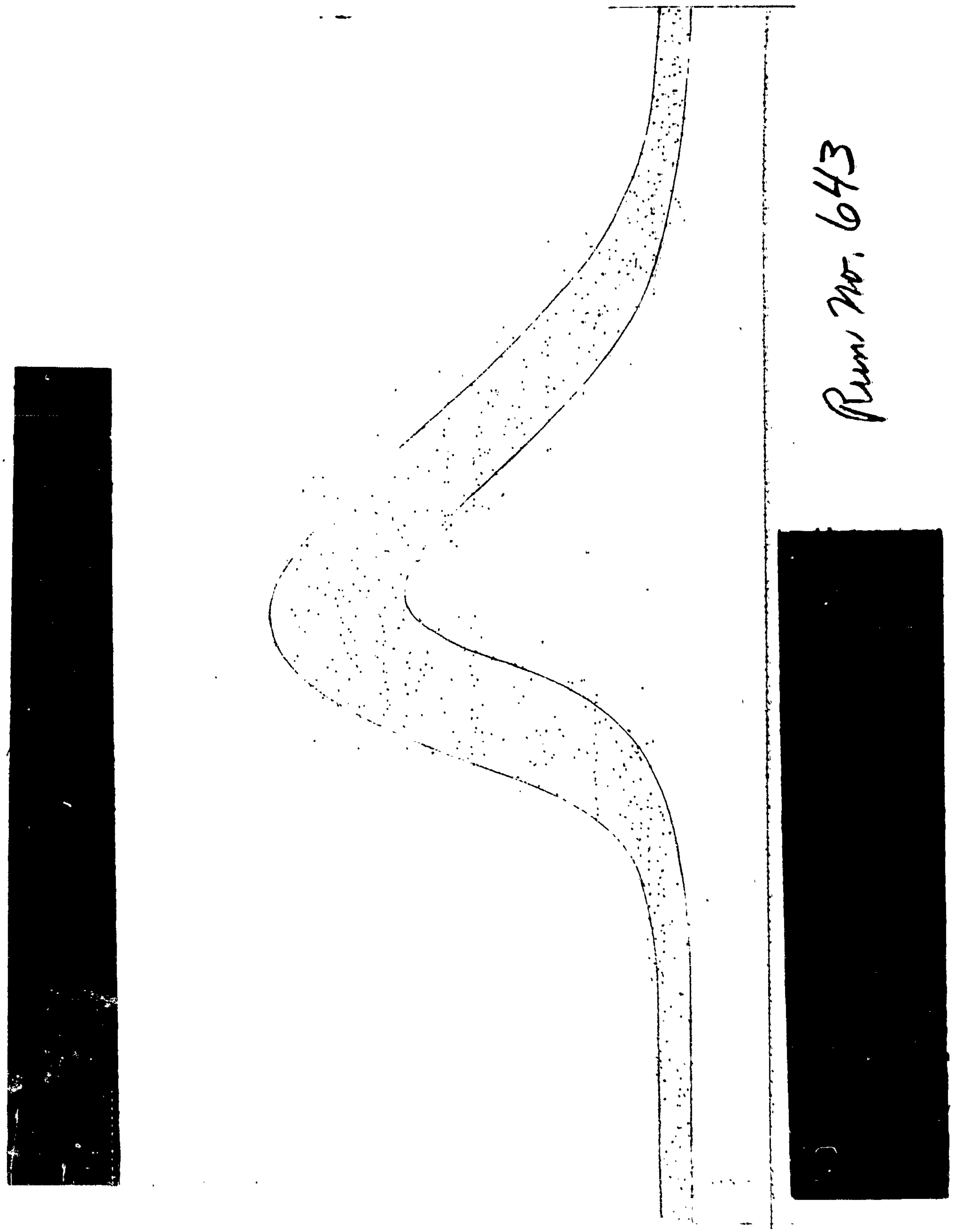
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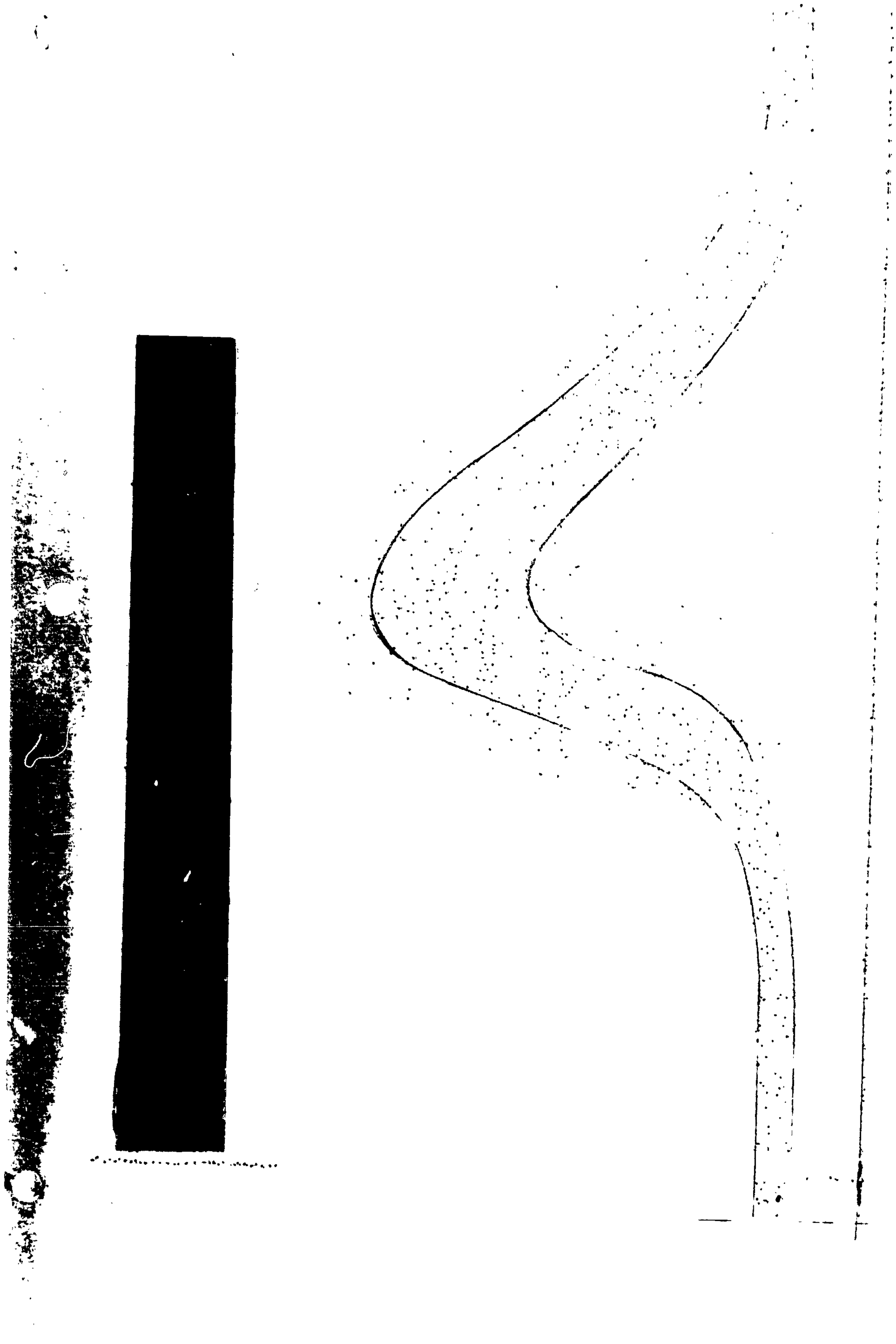

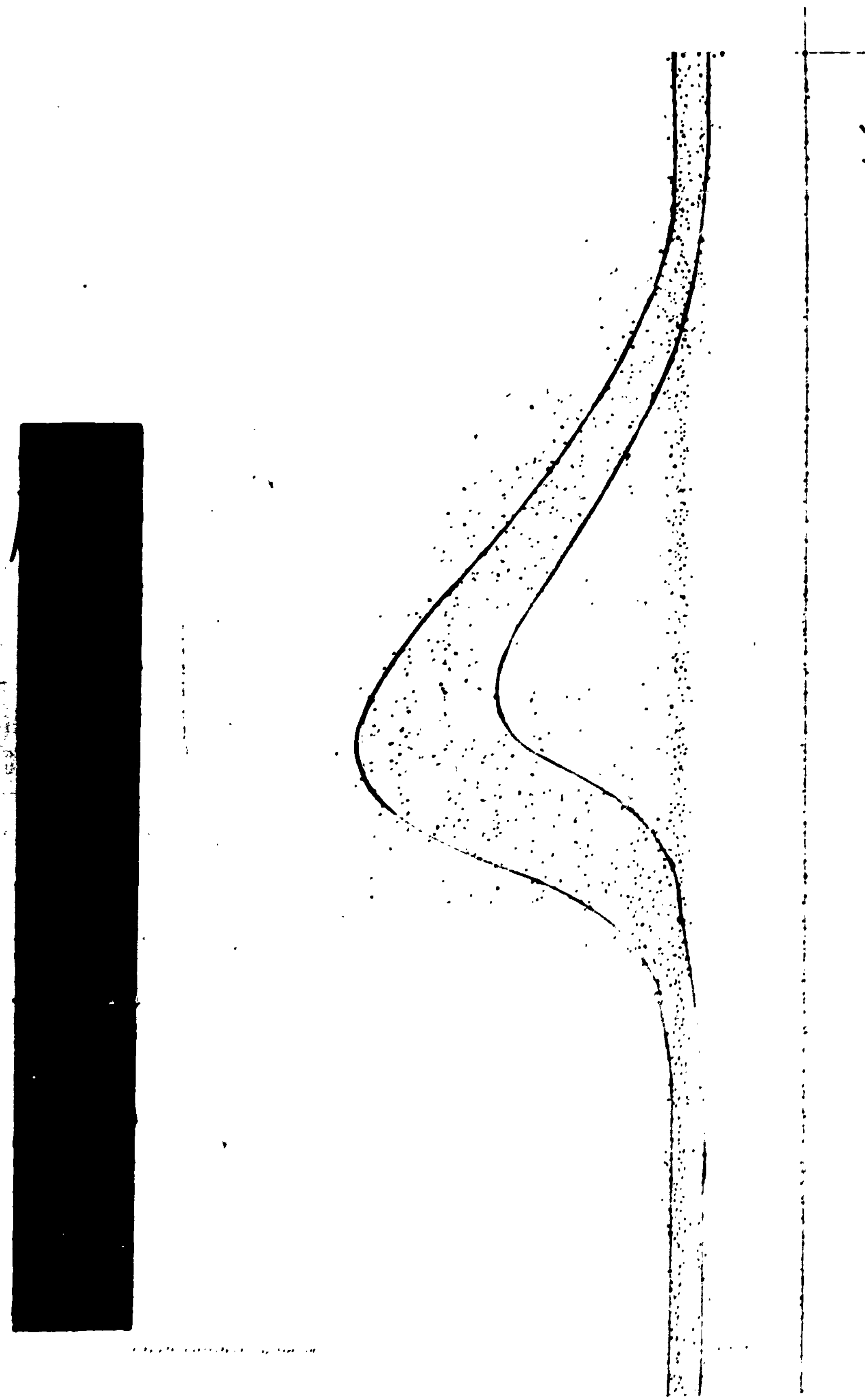

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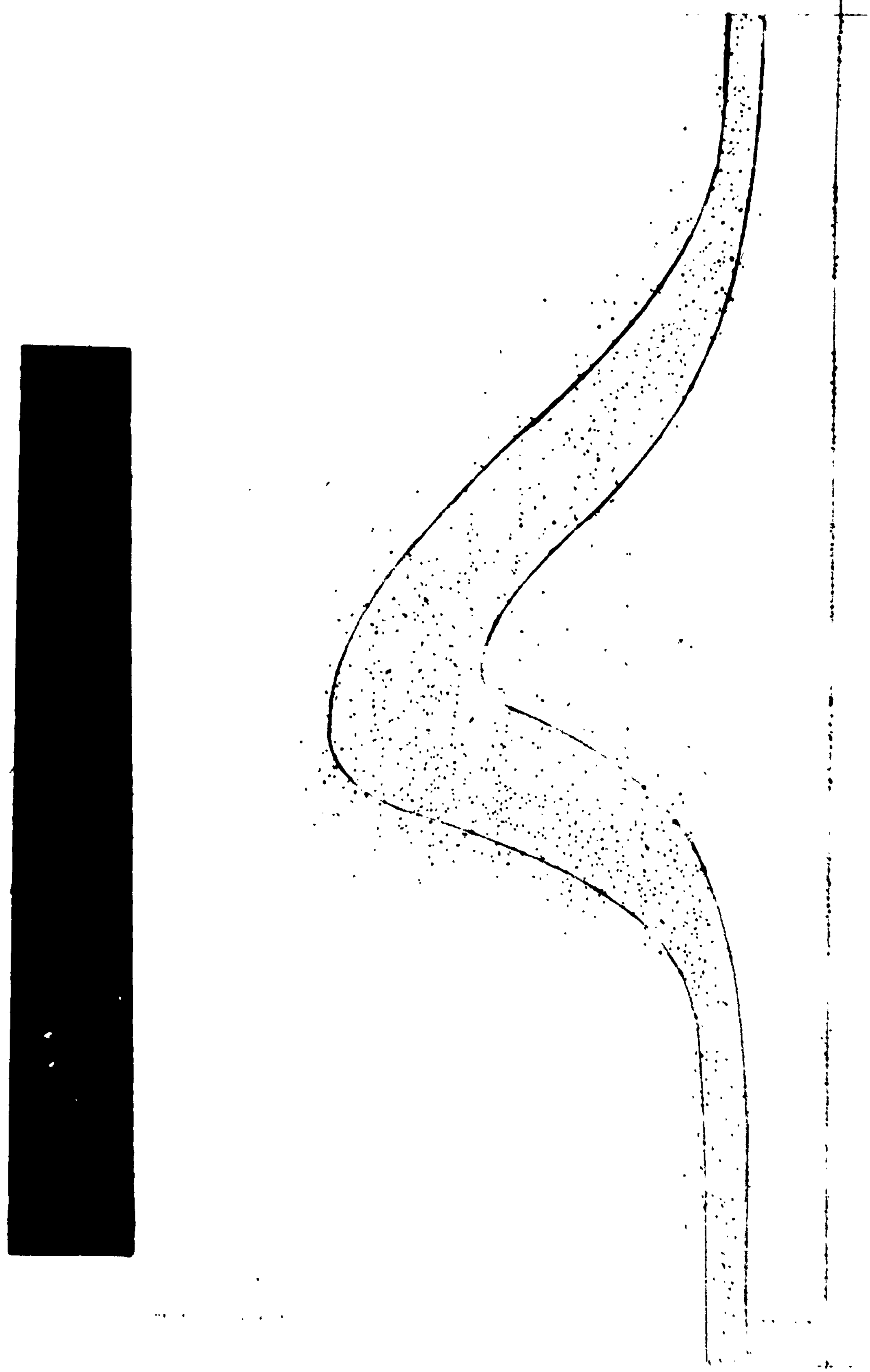

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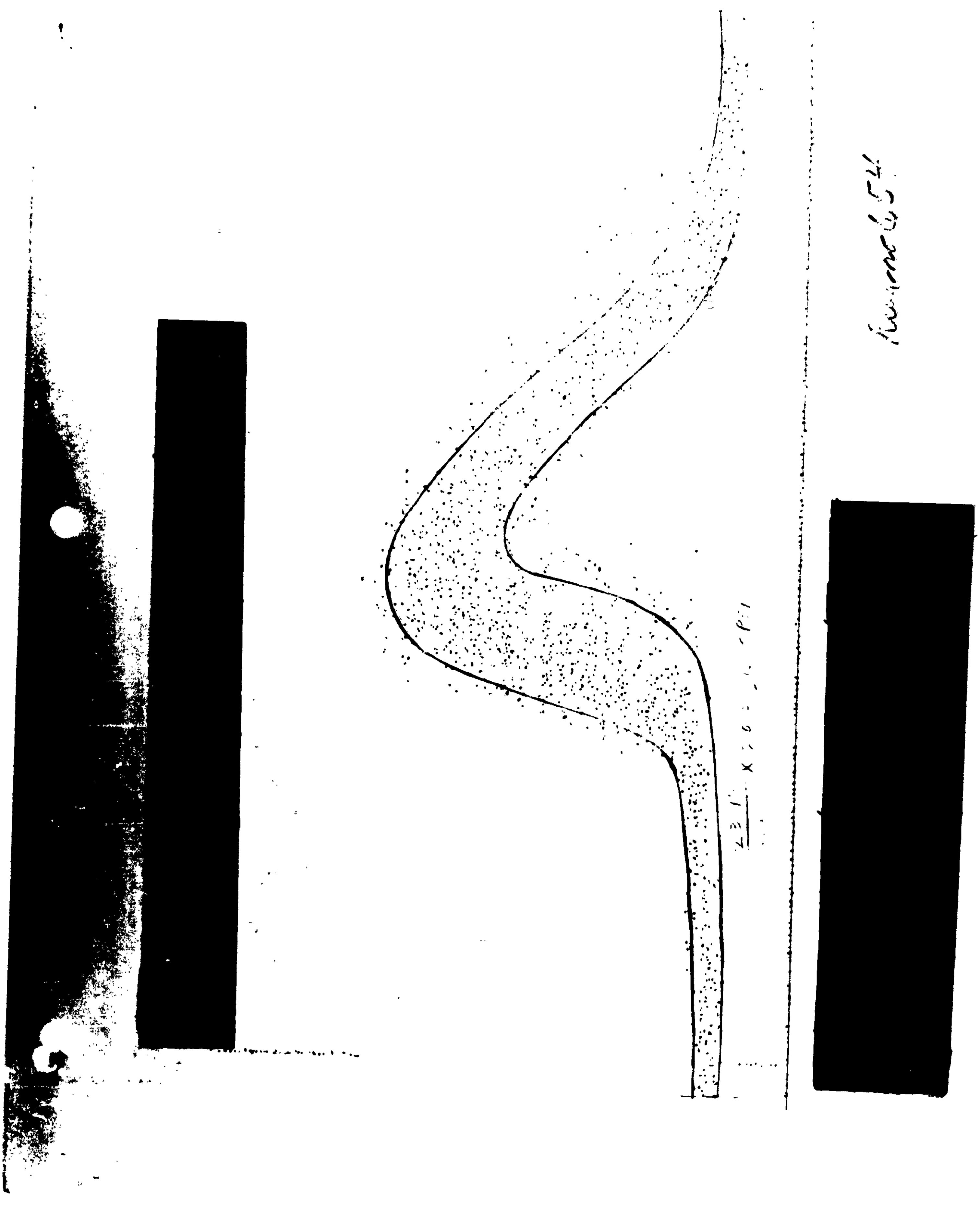
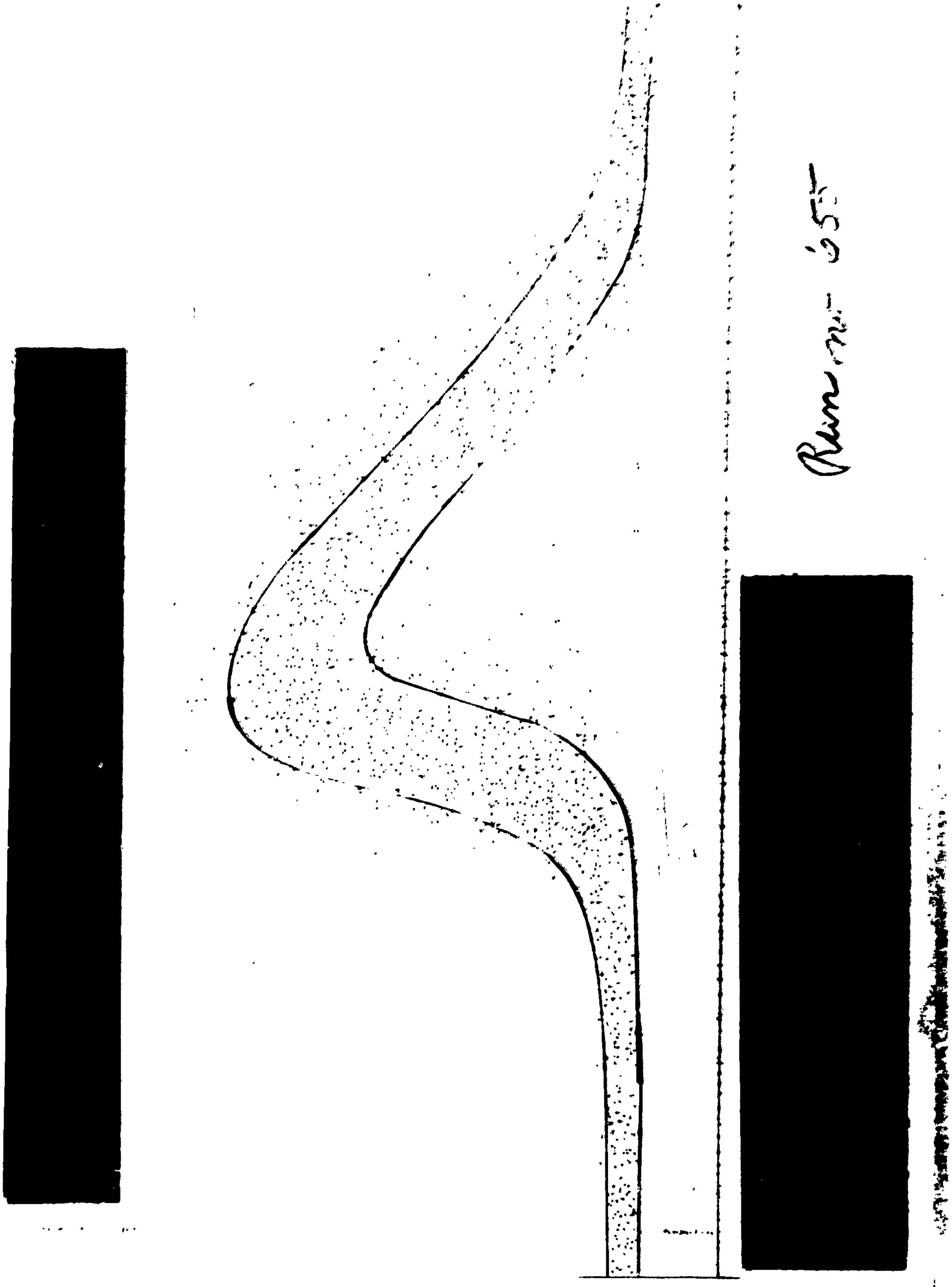


Figure 6.54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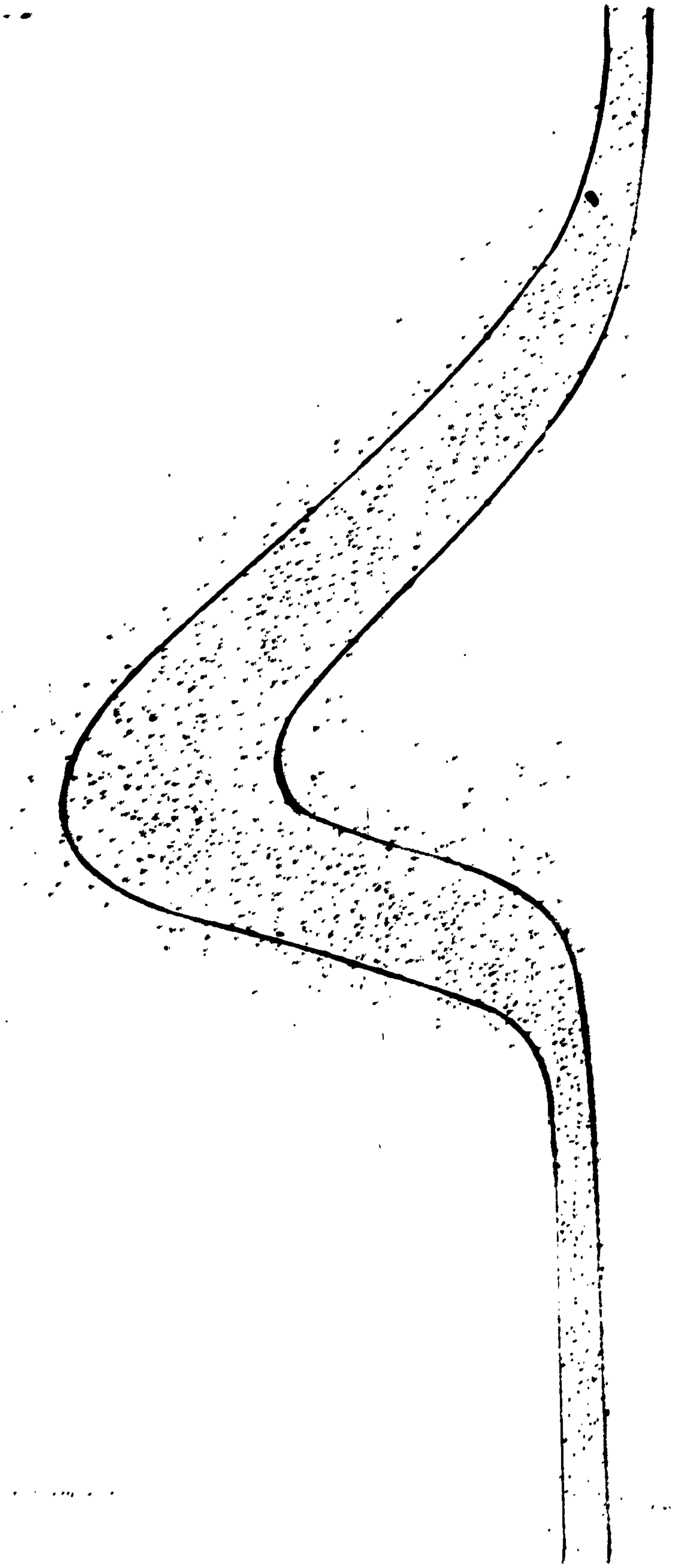

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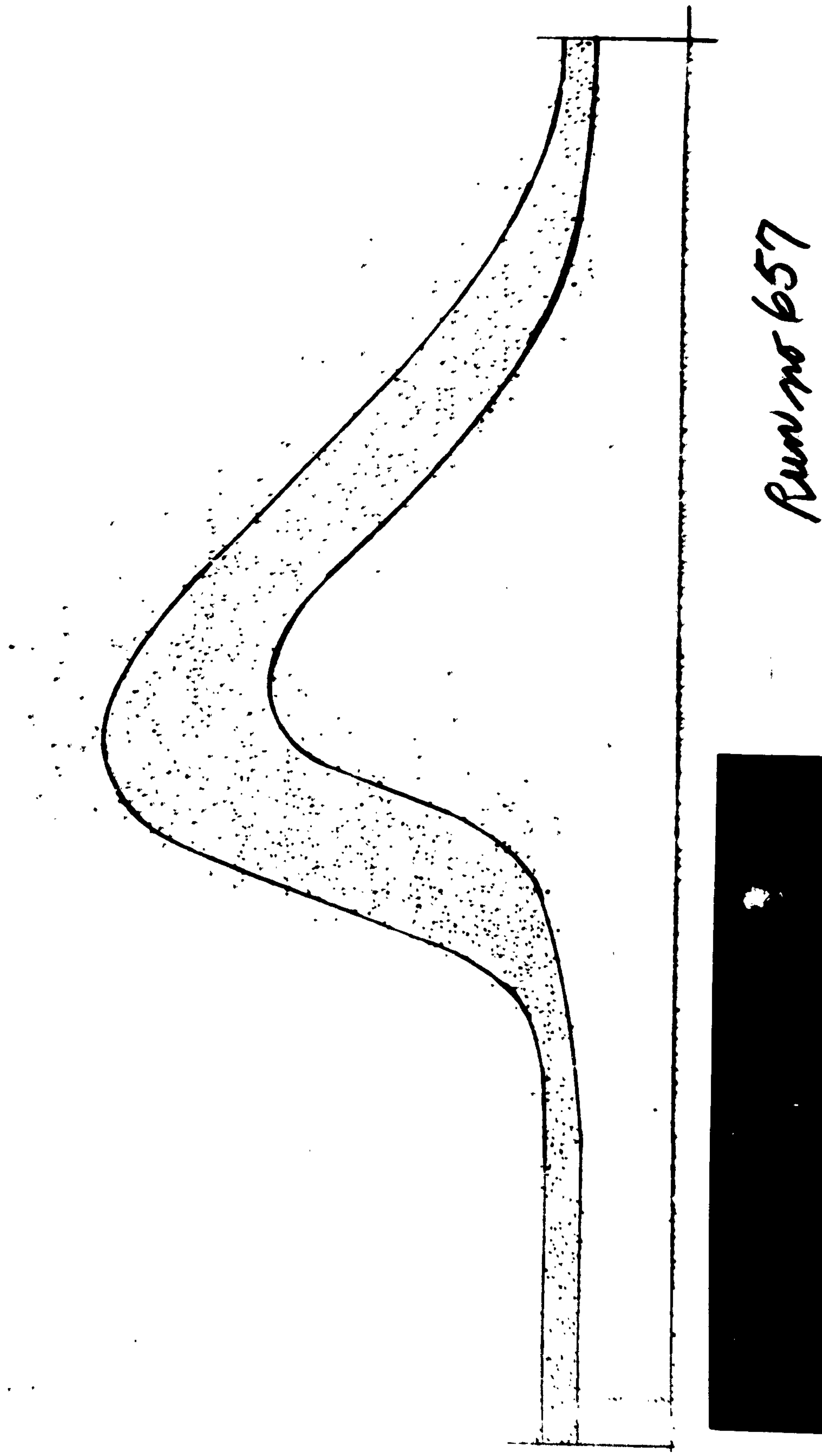

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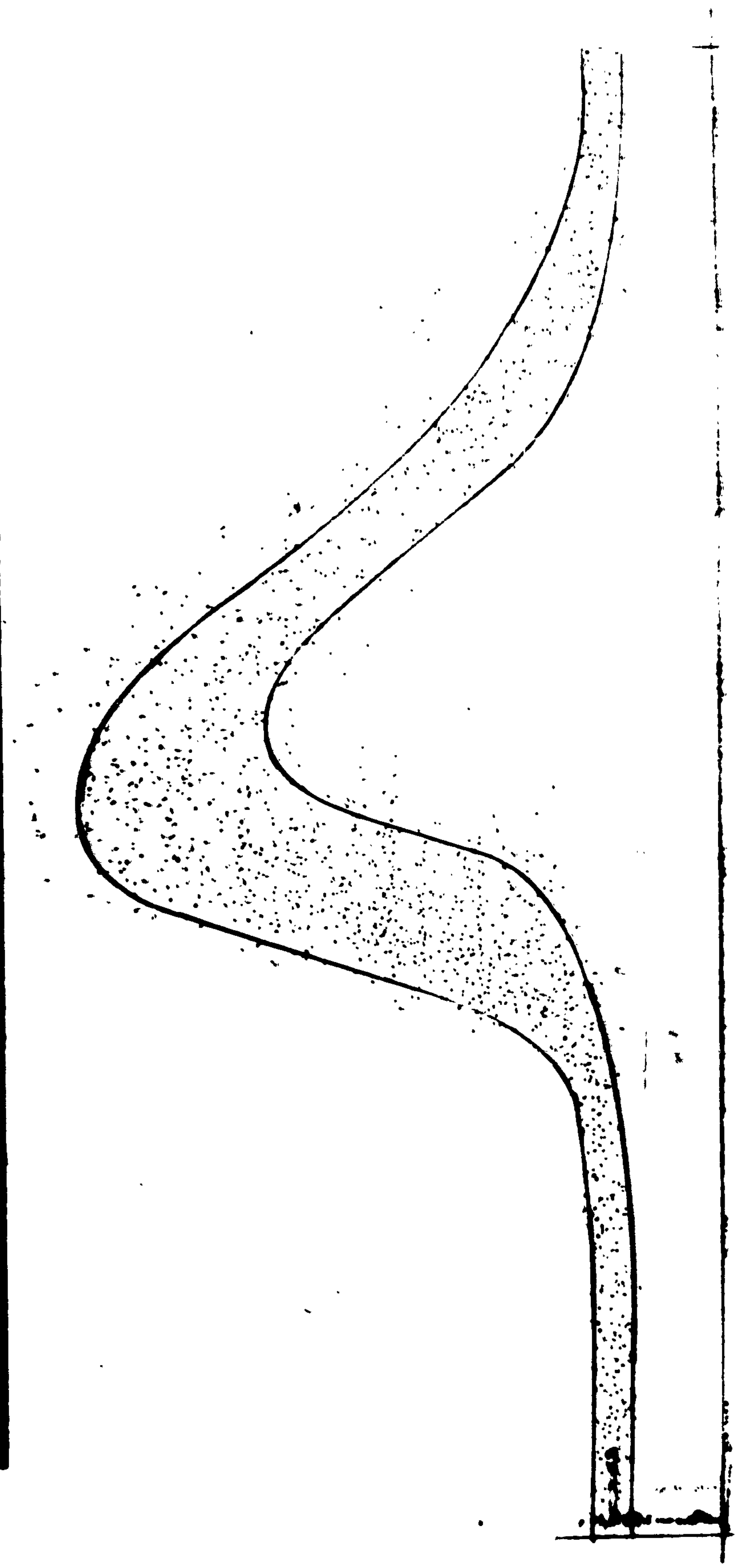
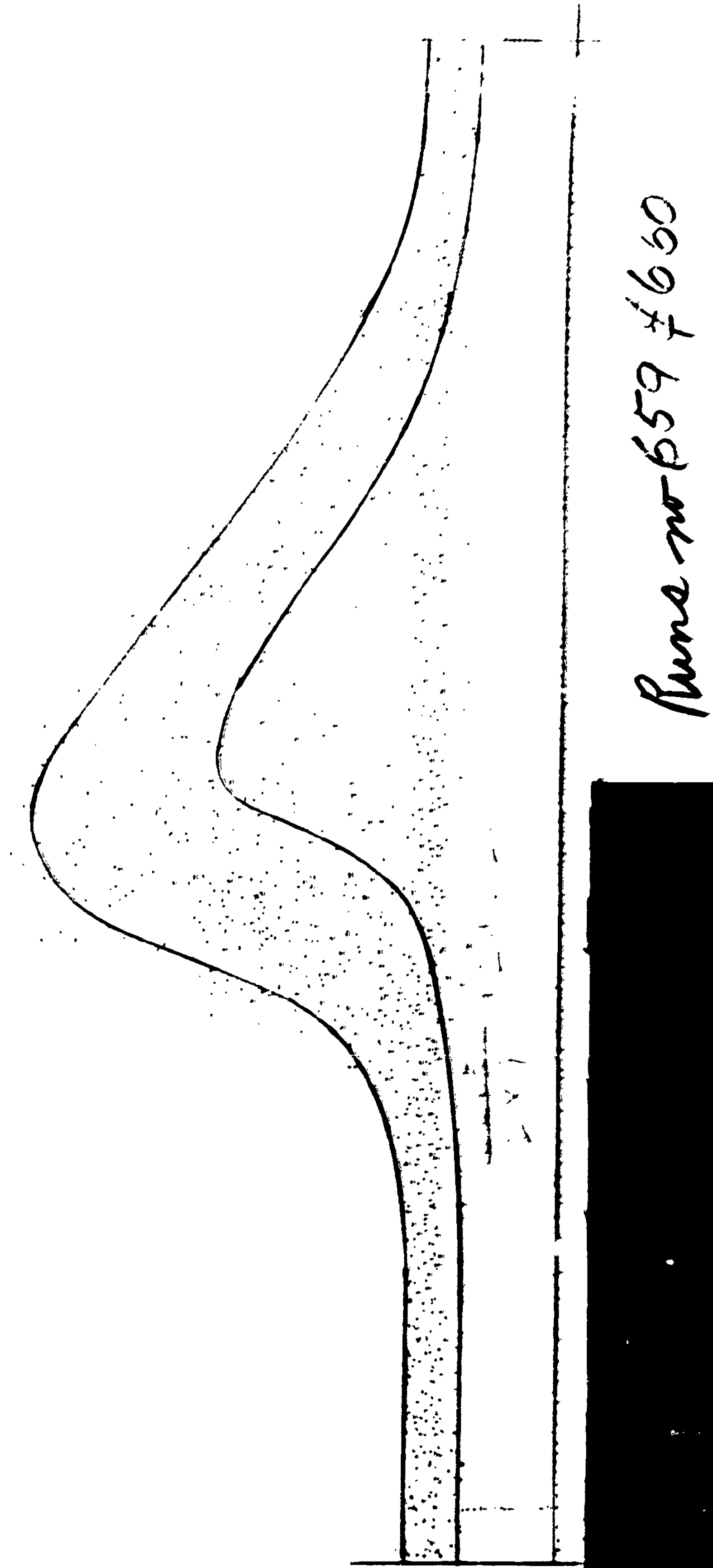


Figure 58



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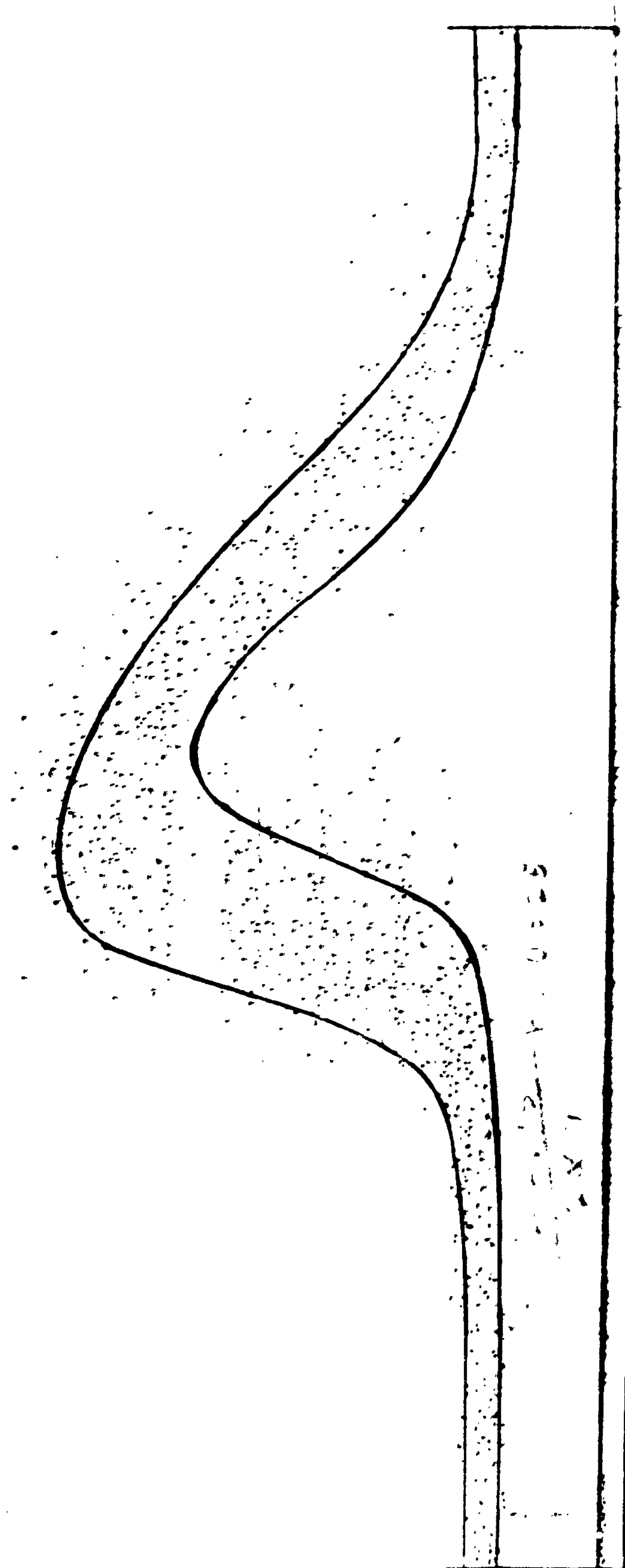

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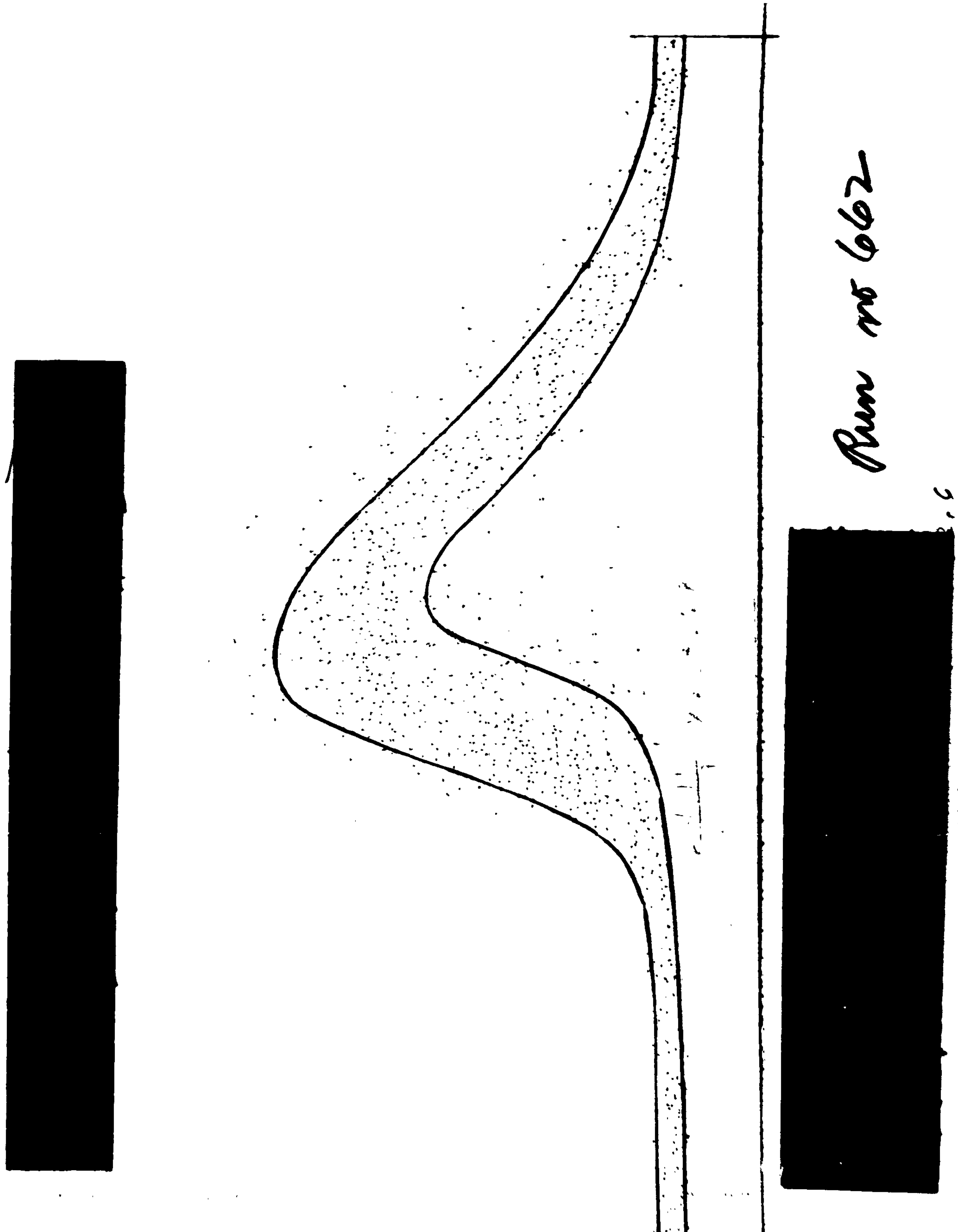
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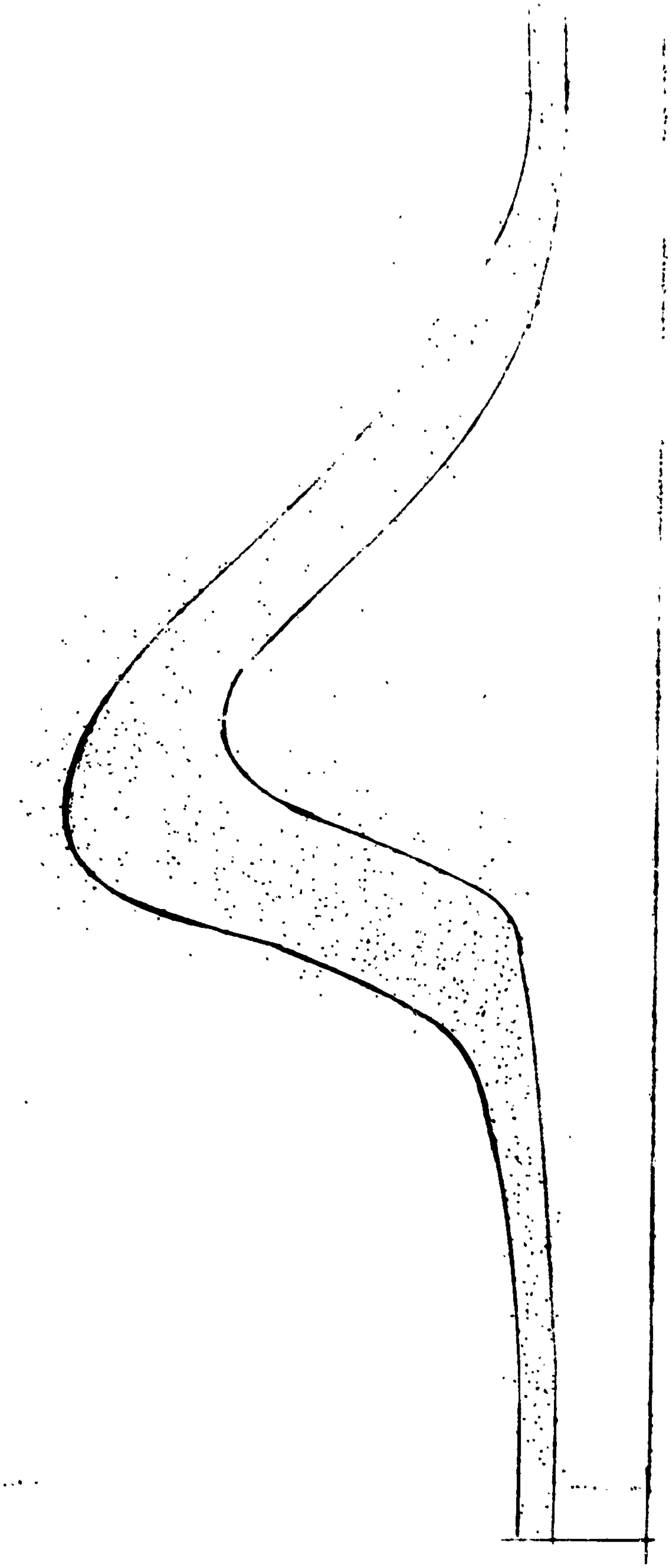

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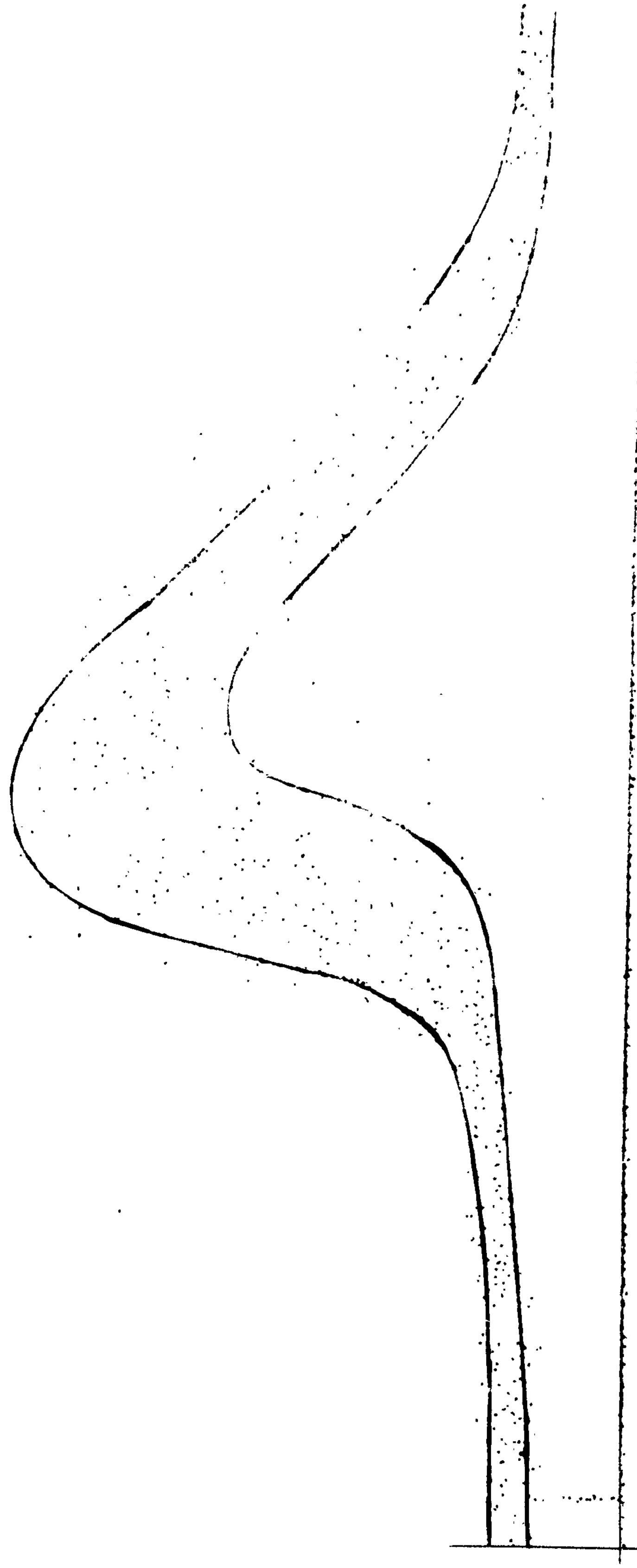

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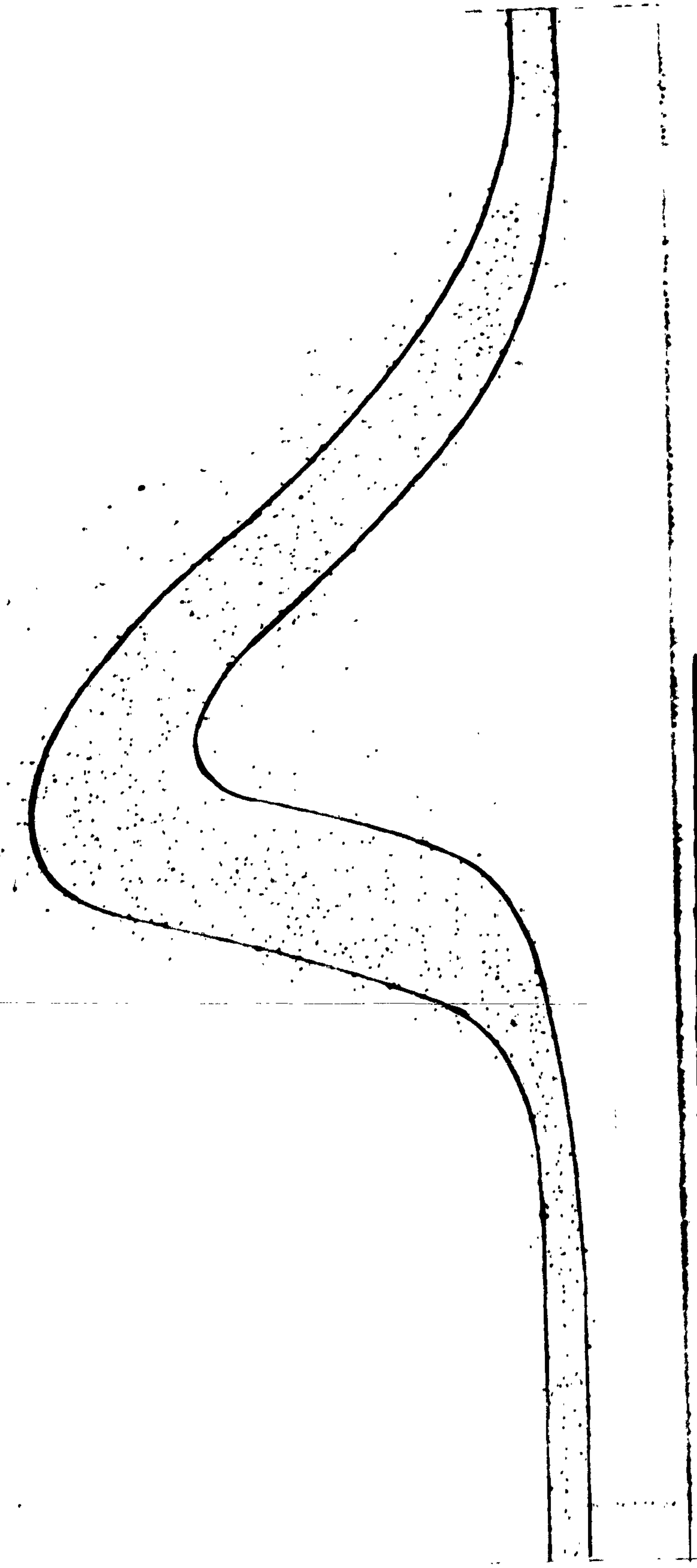

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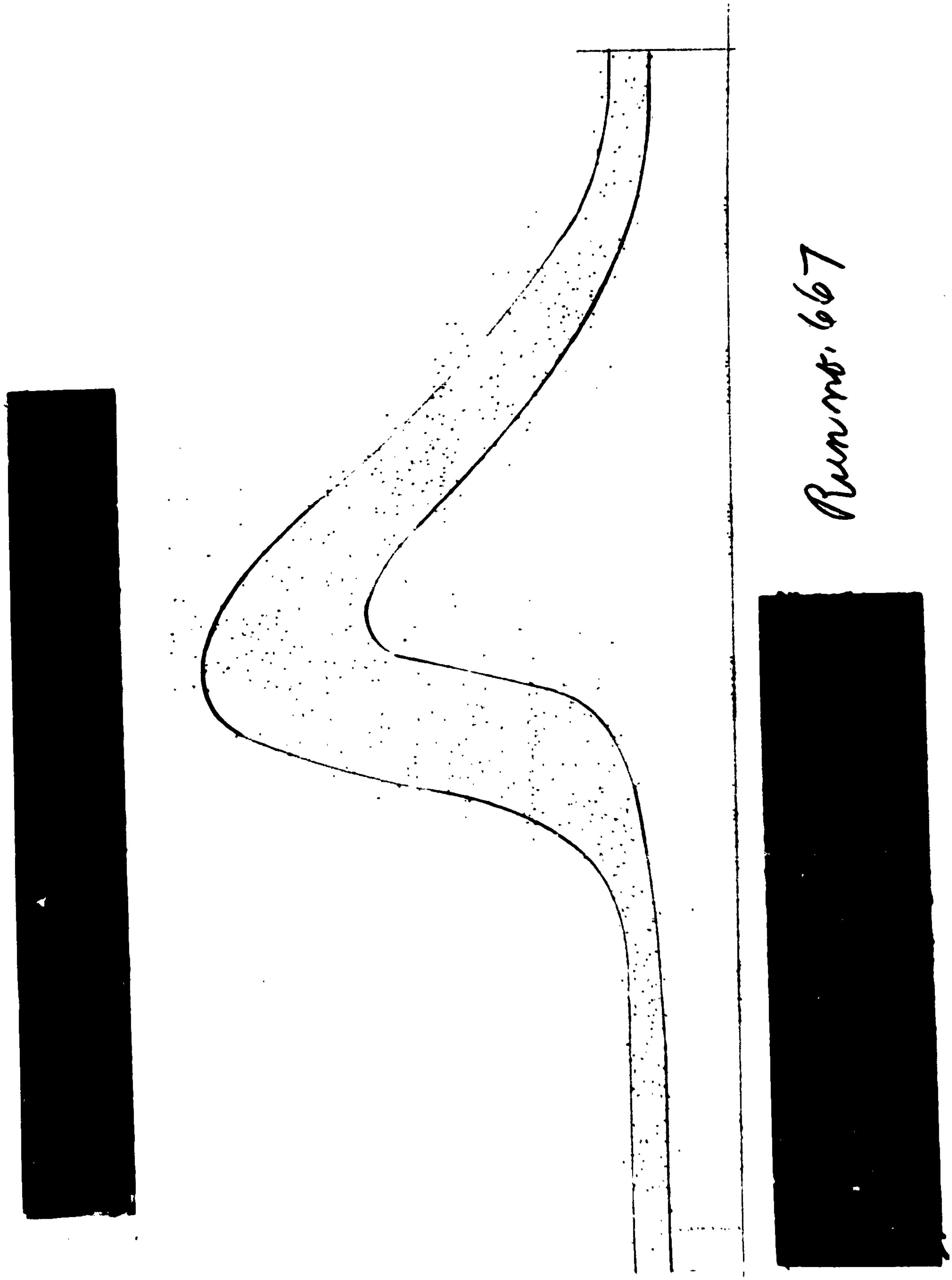
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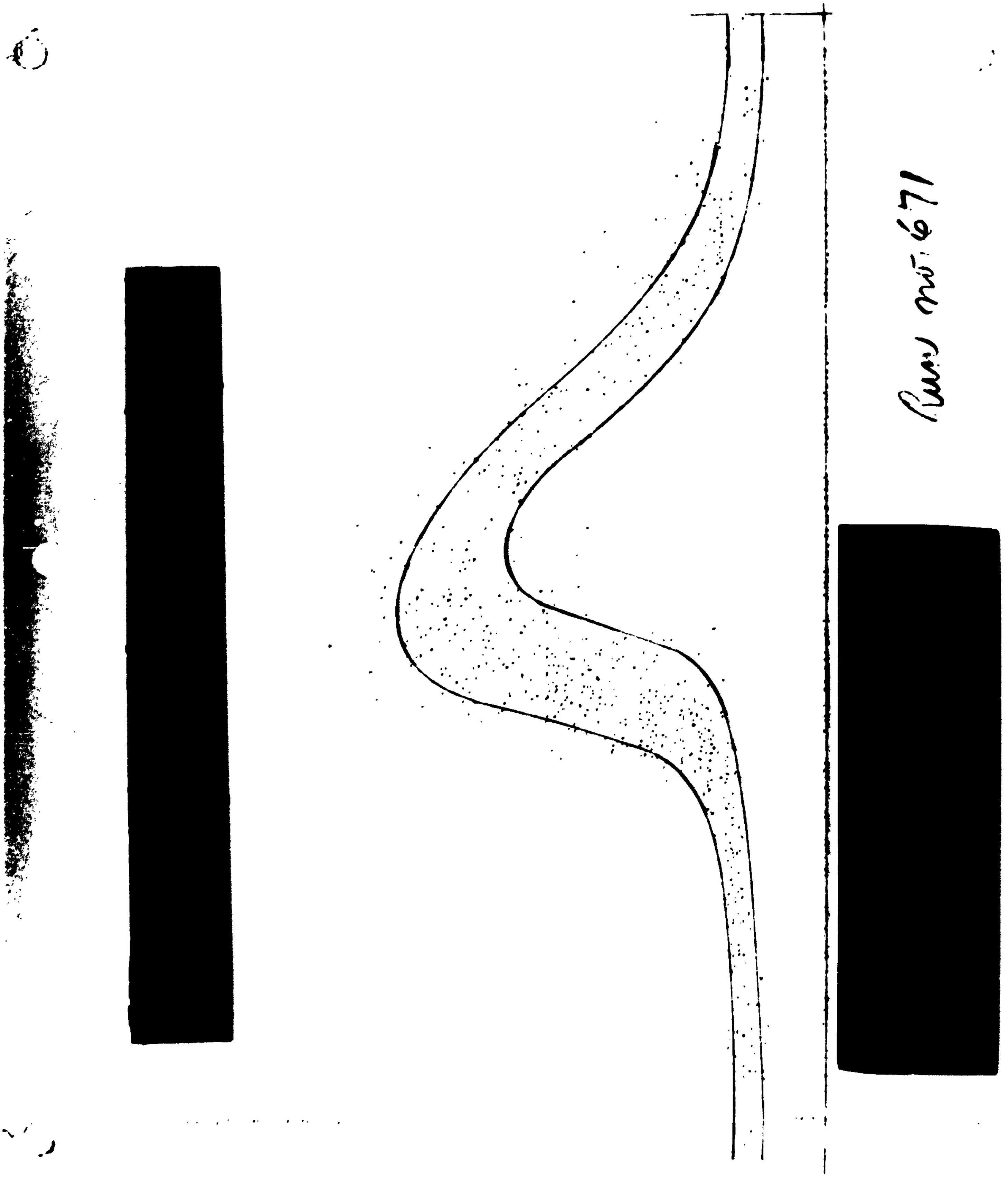
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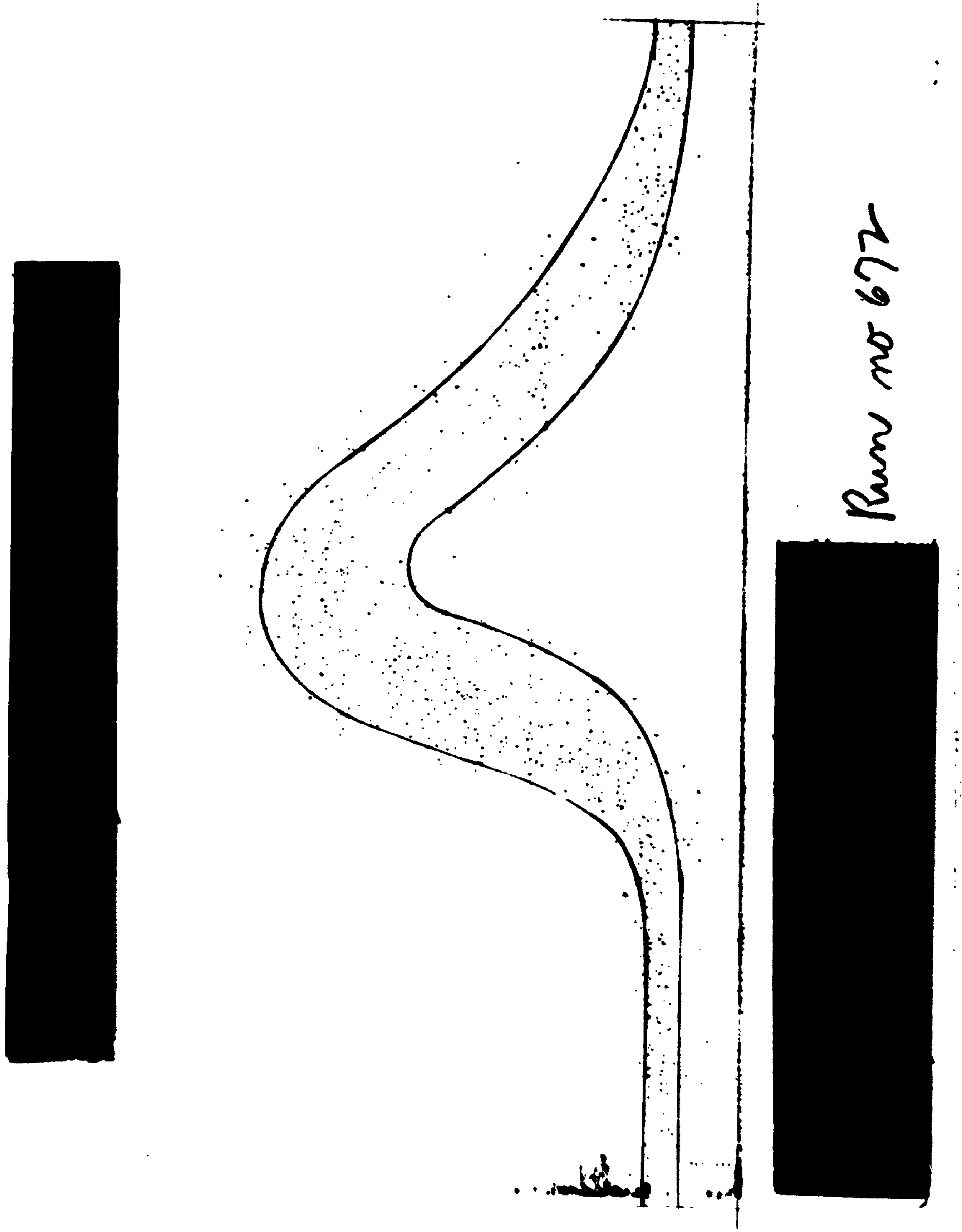
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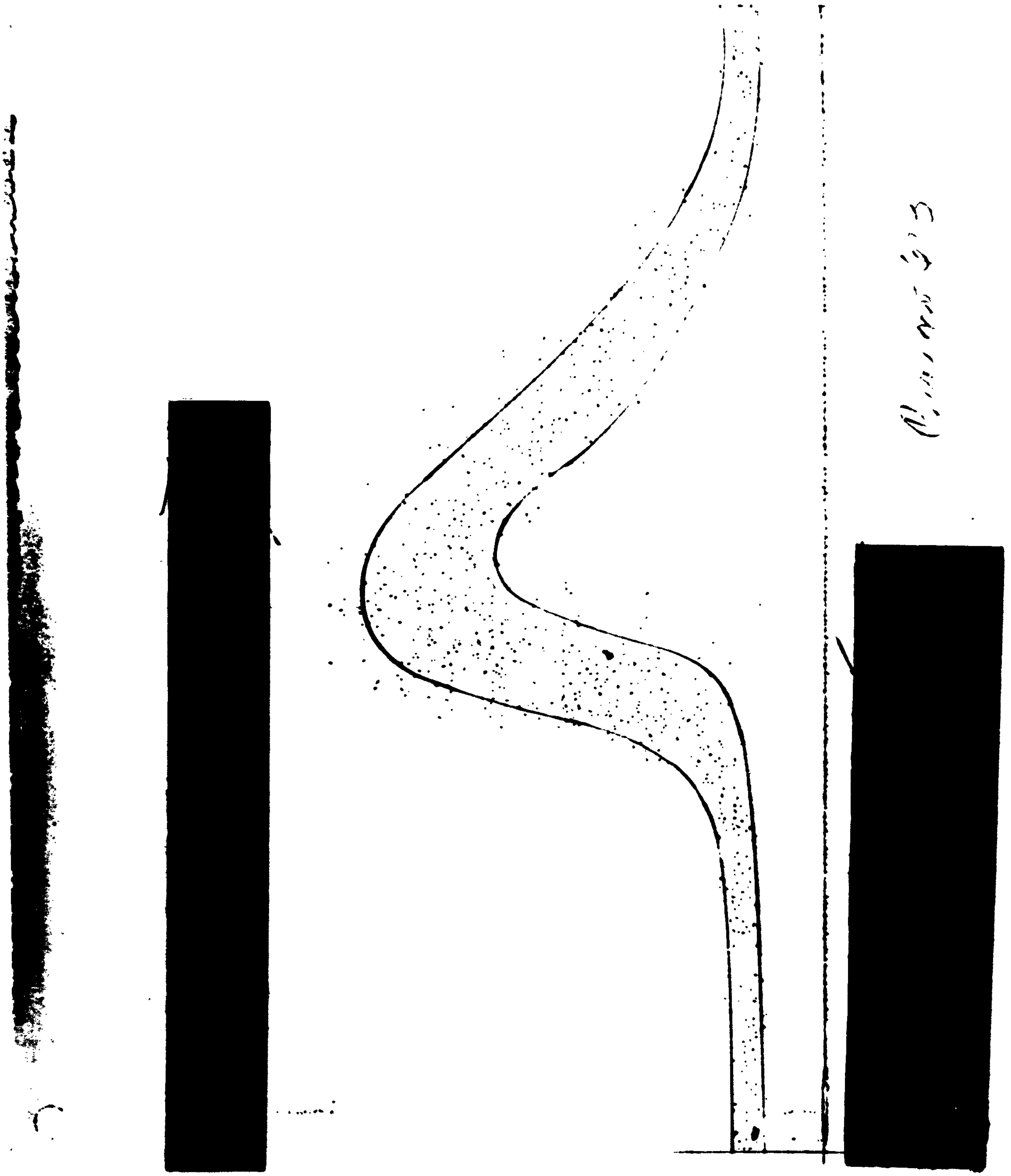

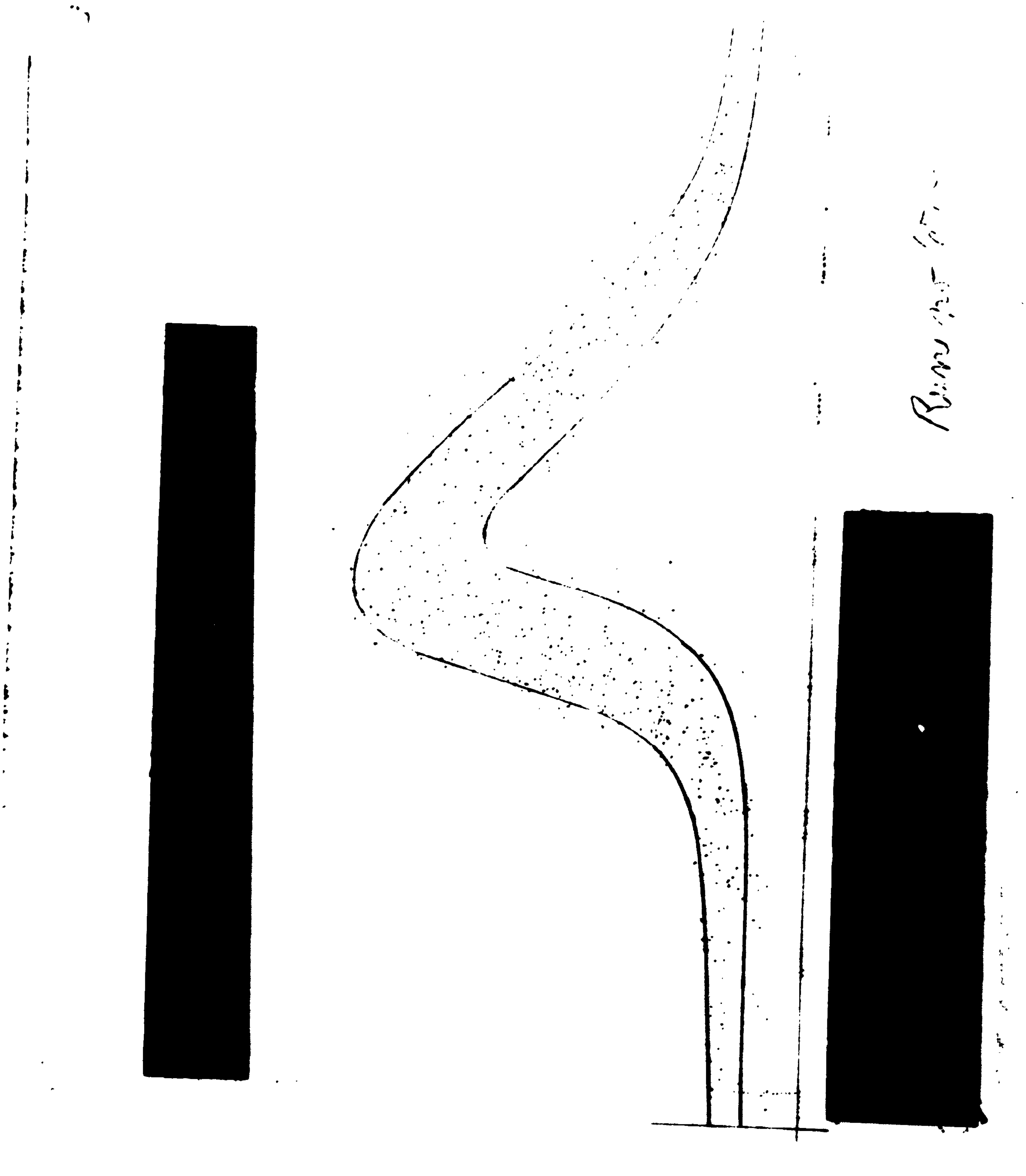

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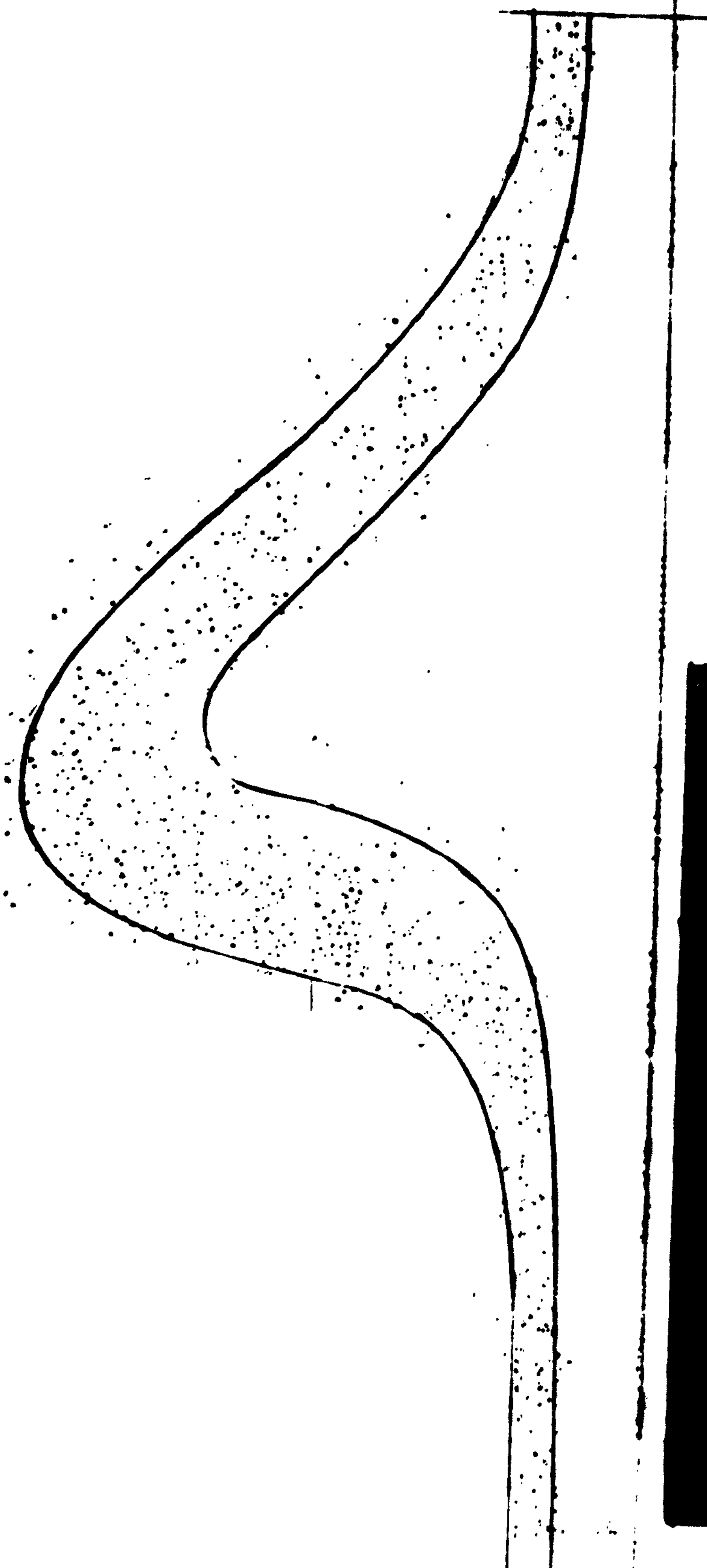

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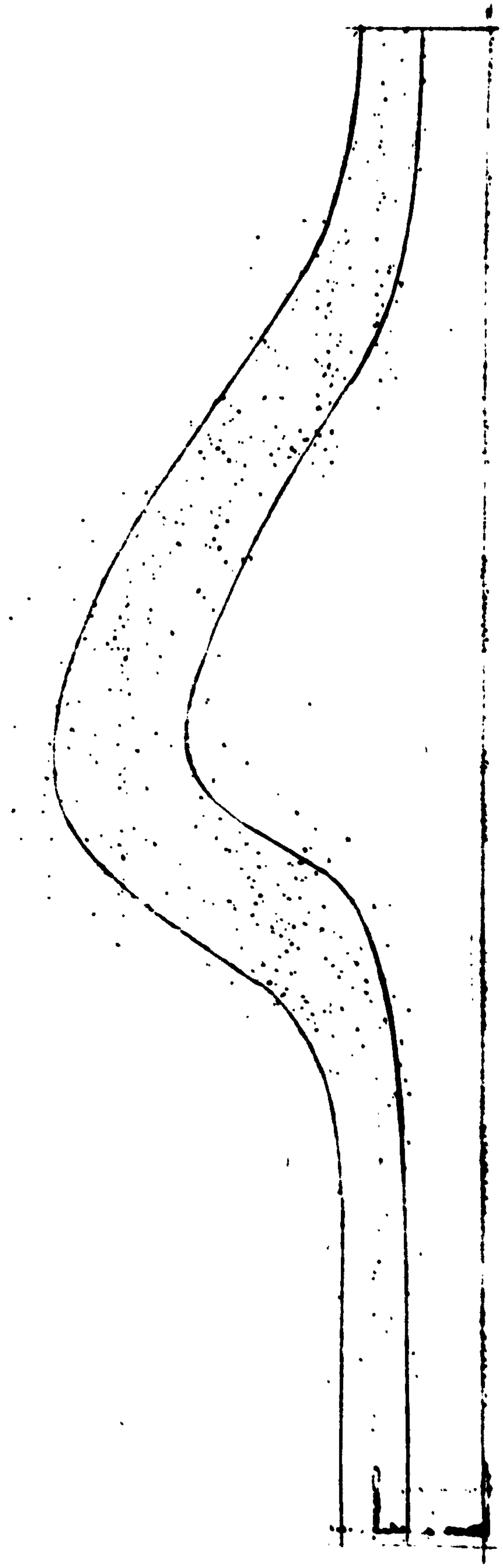

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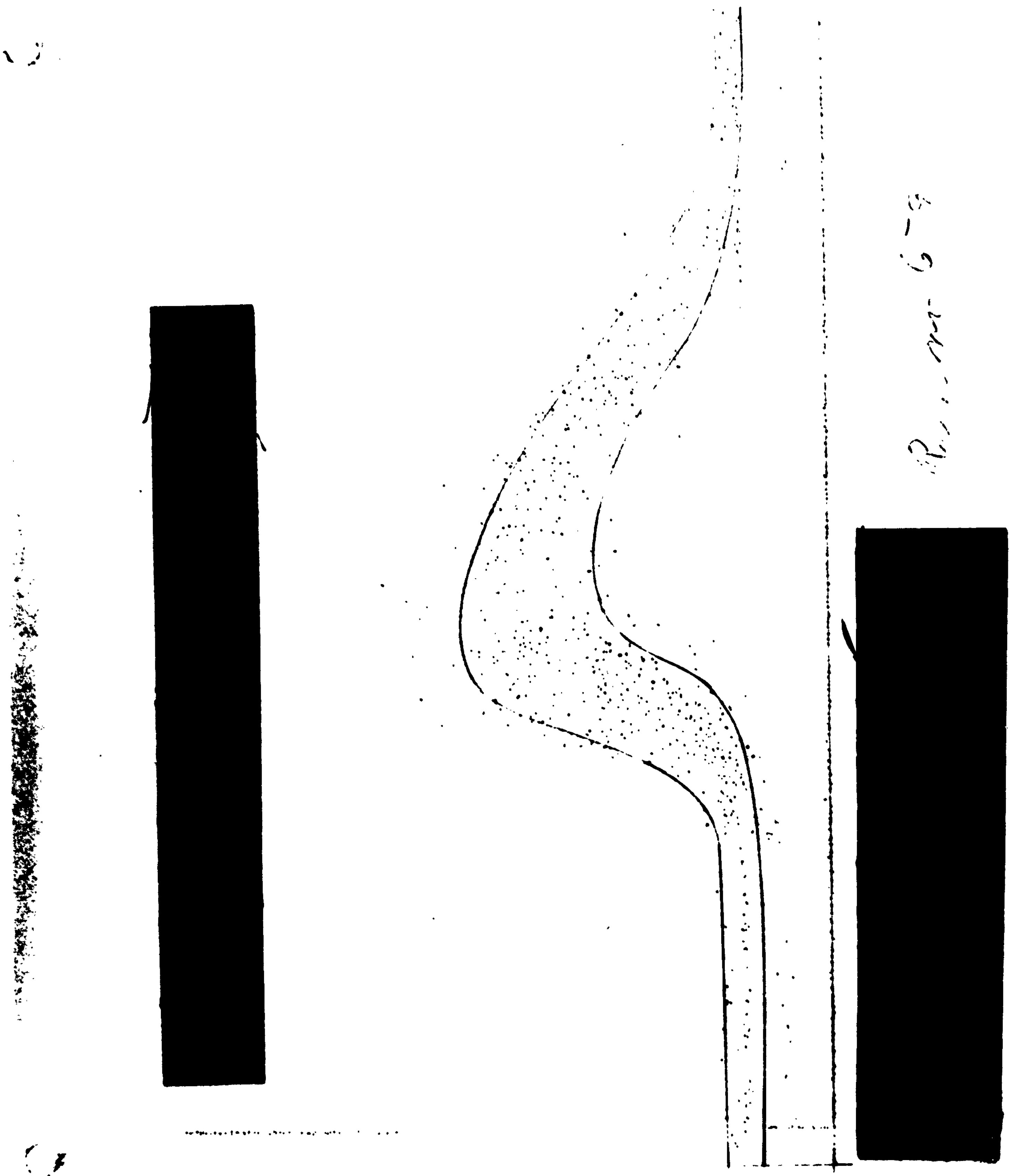

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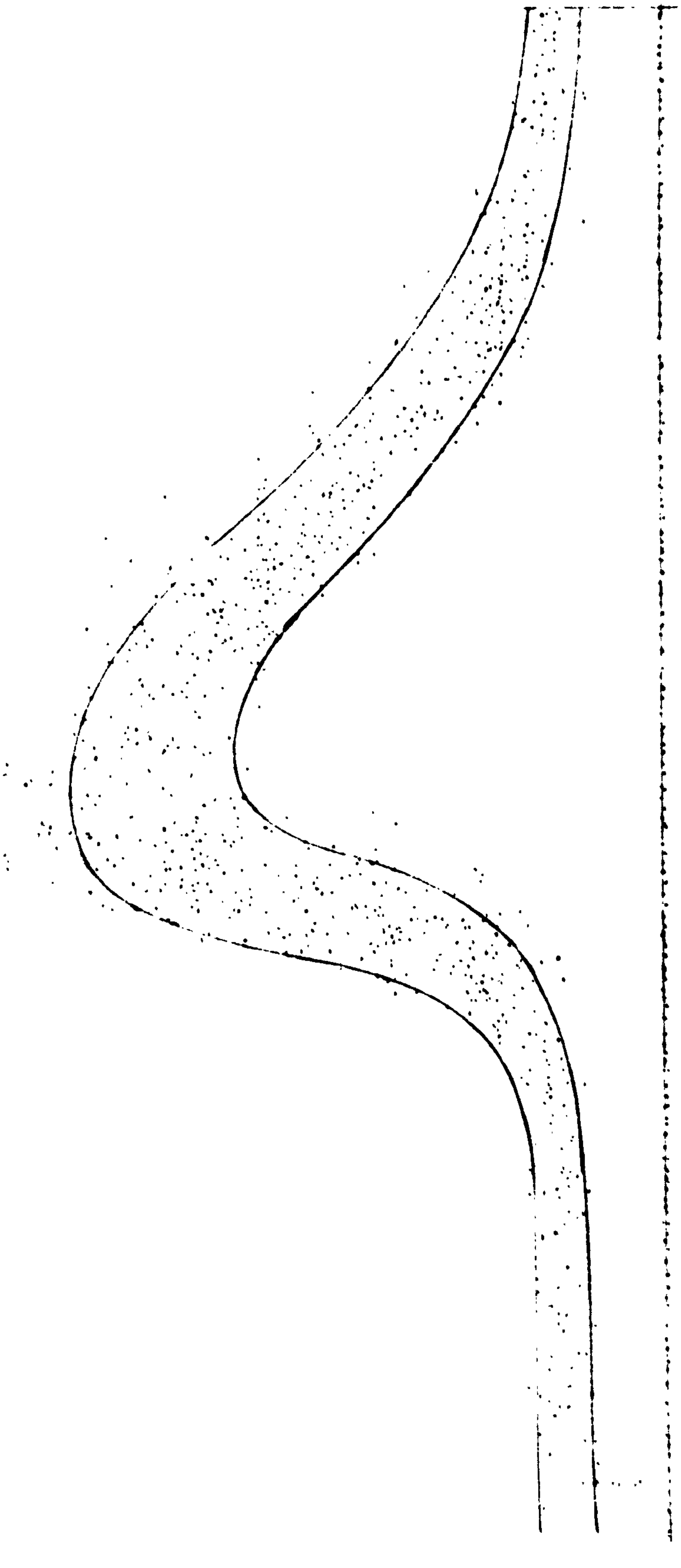

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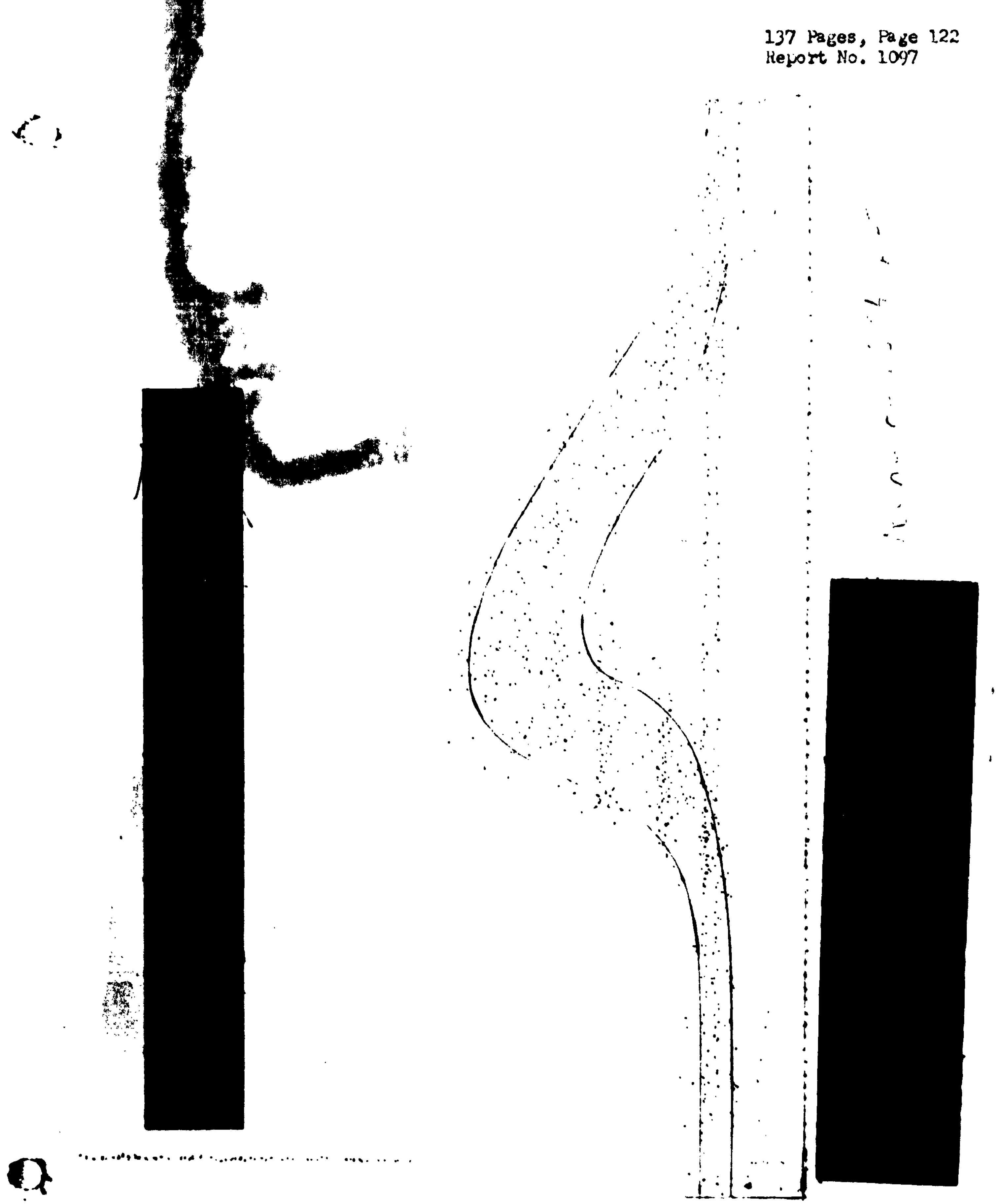

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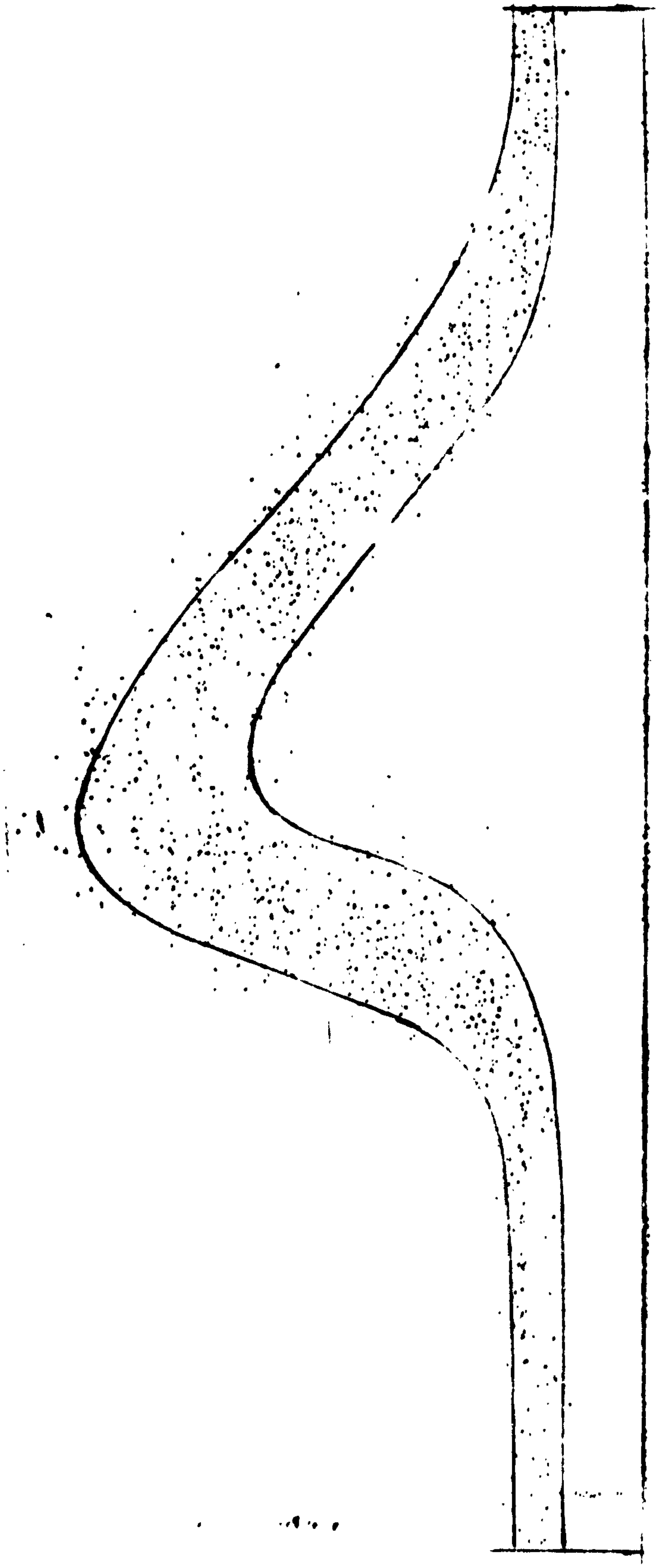

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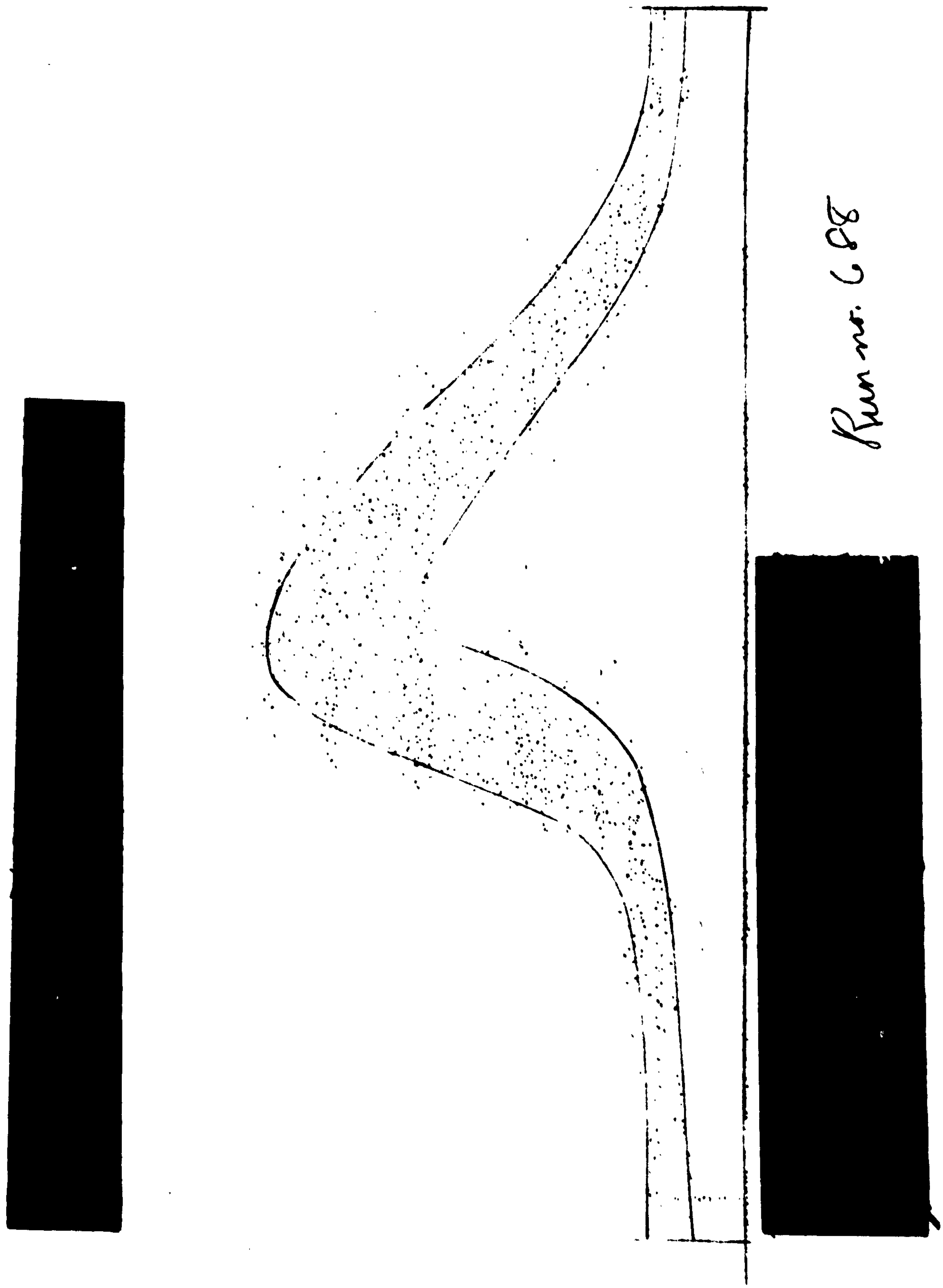
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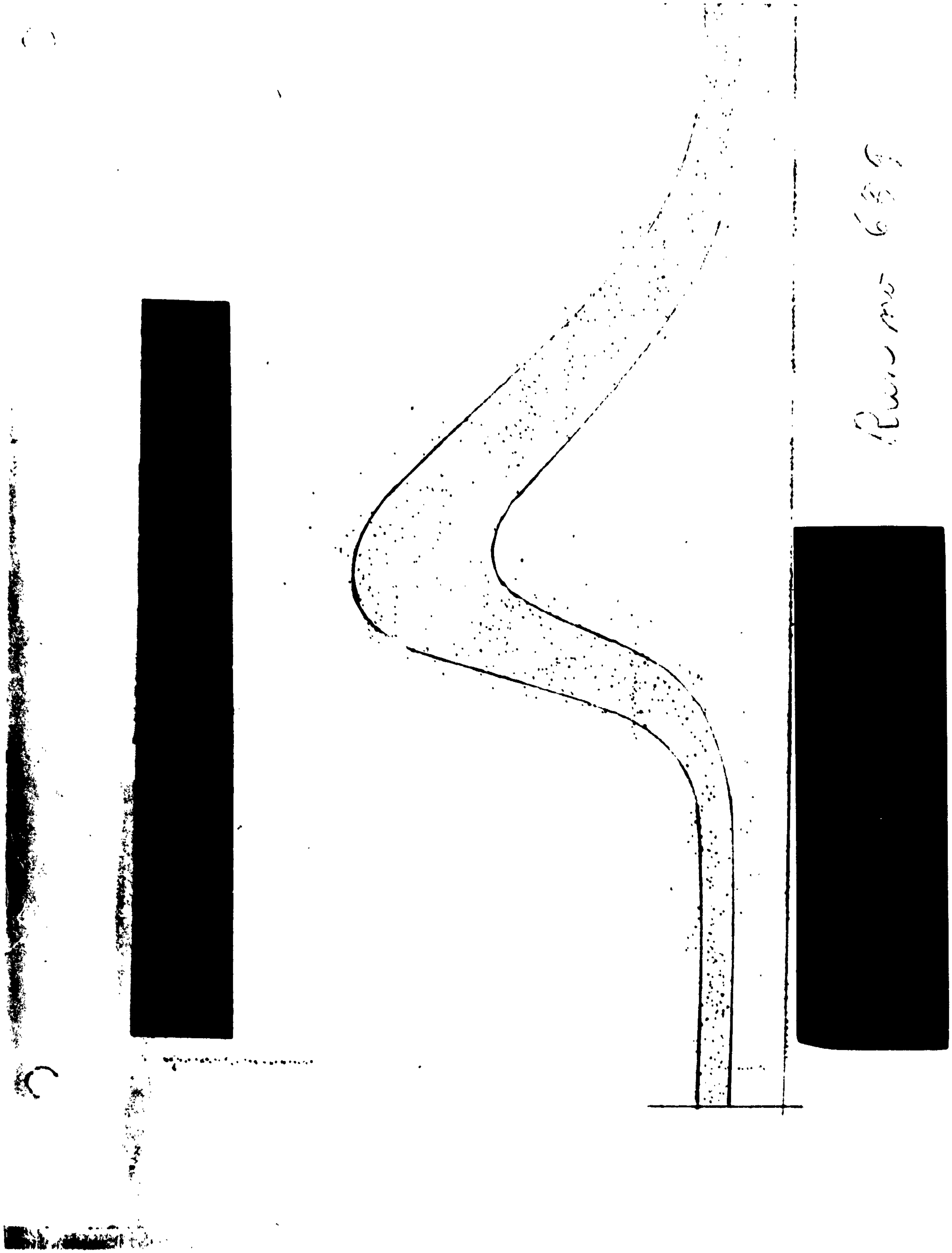

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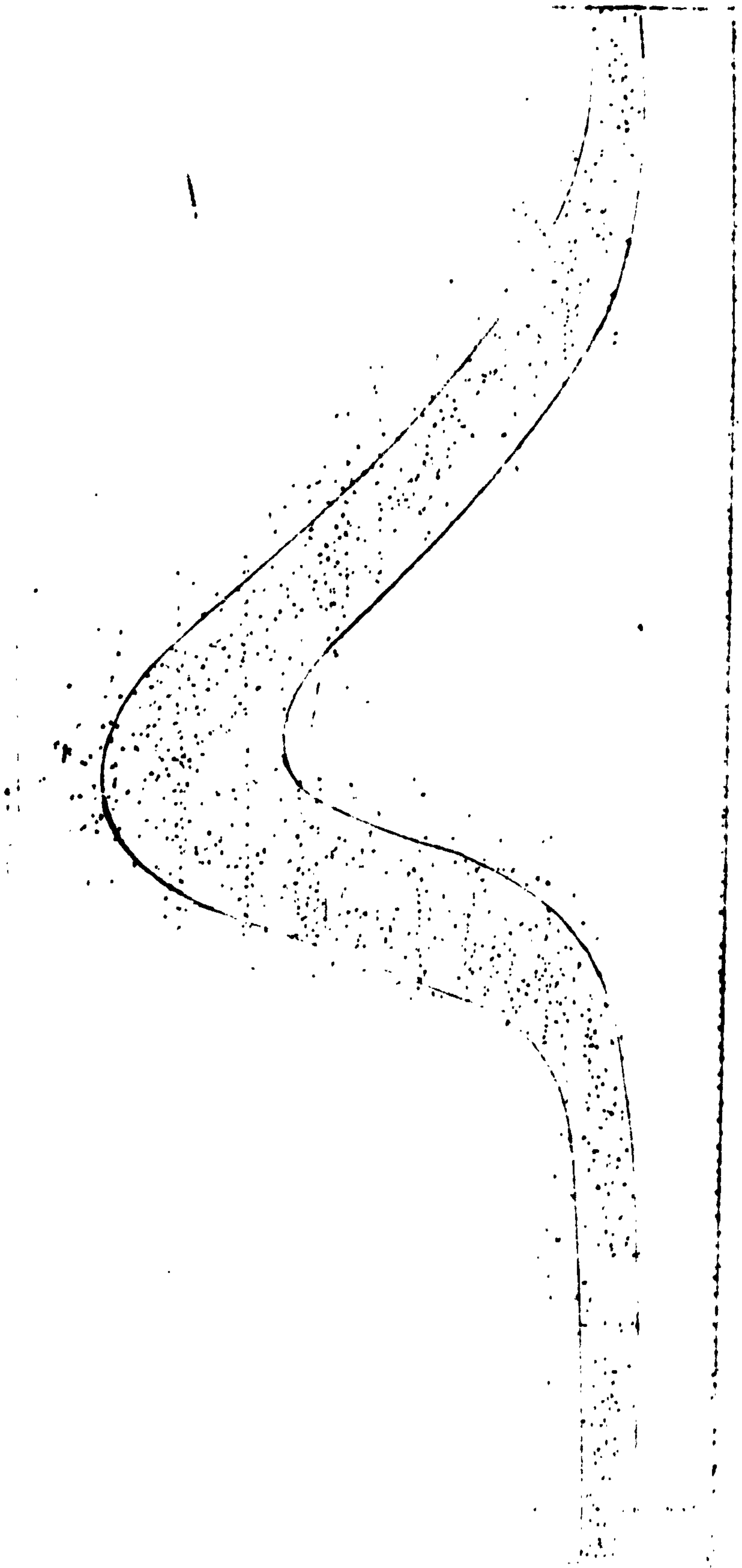

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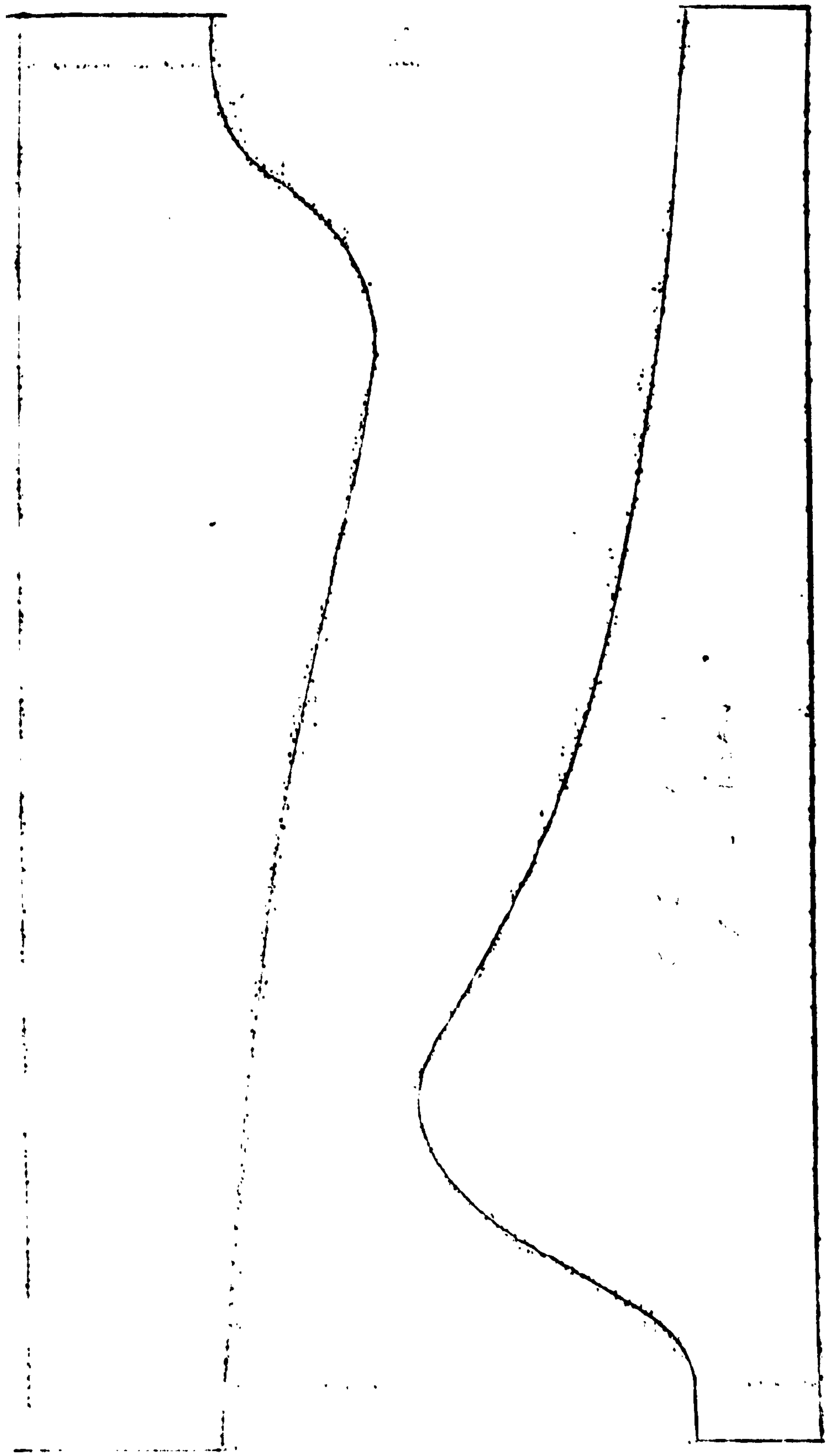

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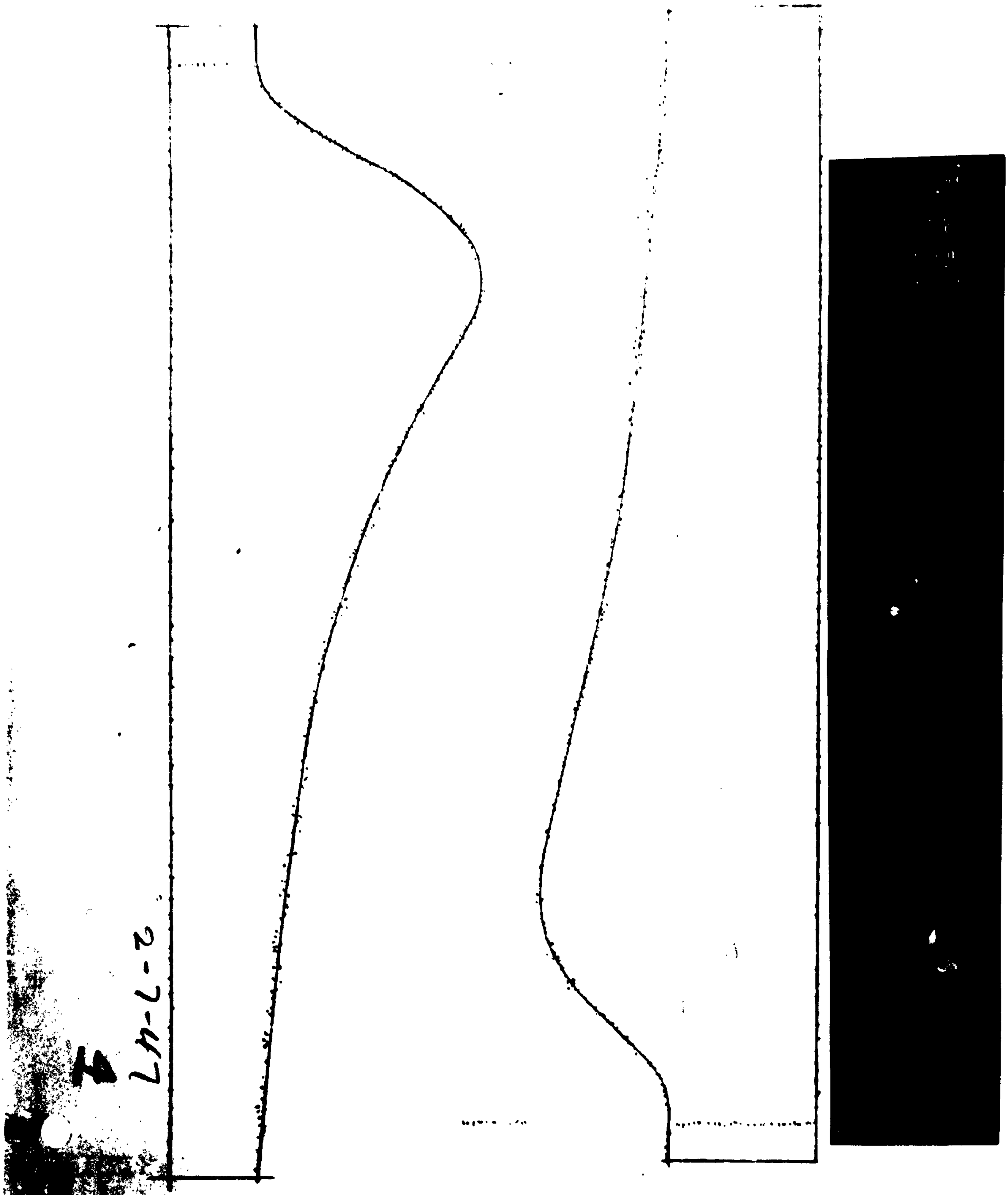
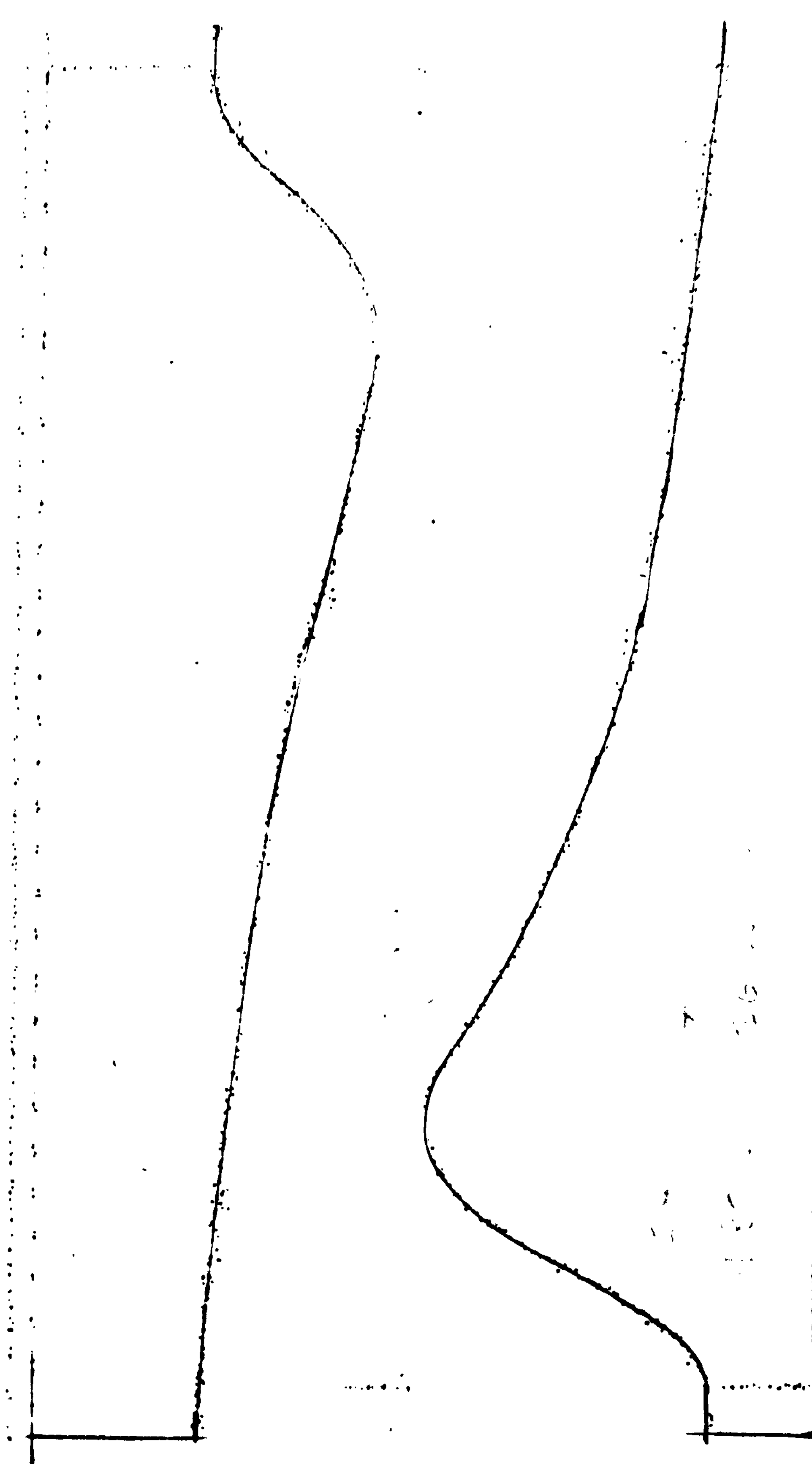

2-7-47



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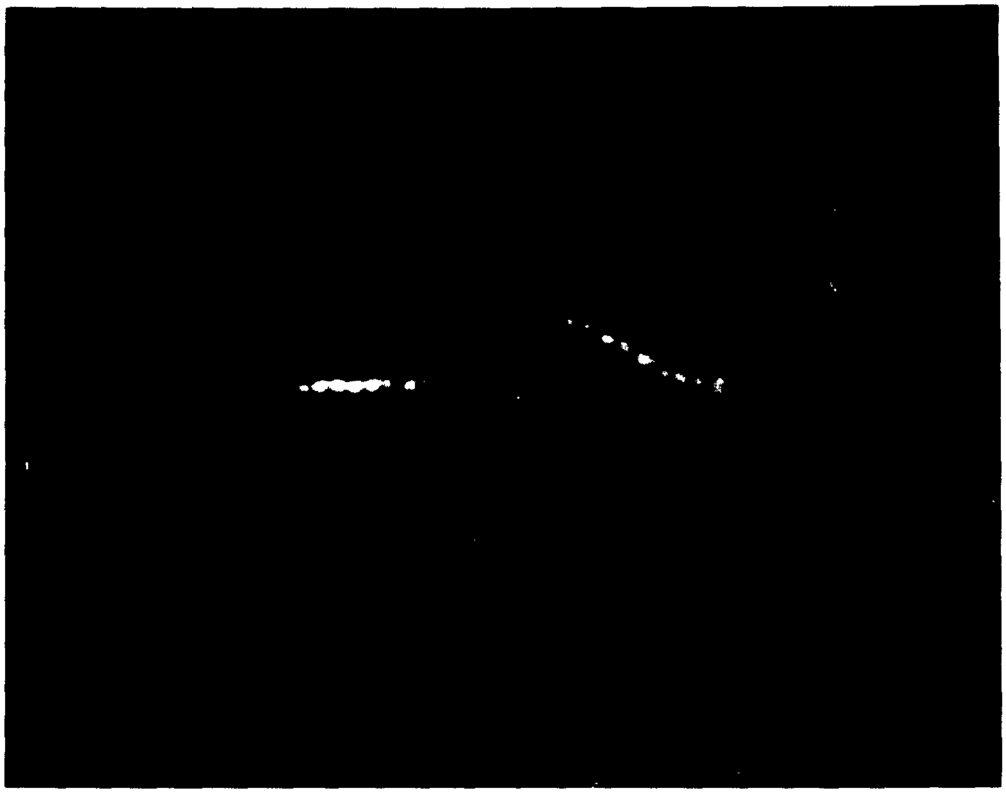
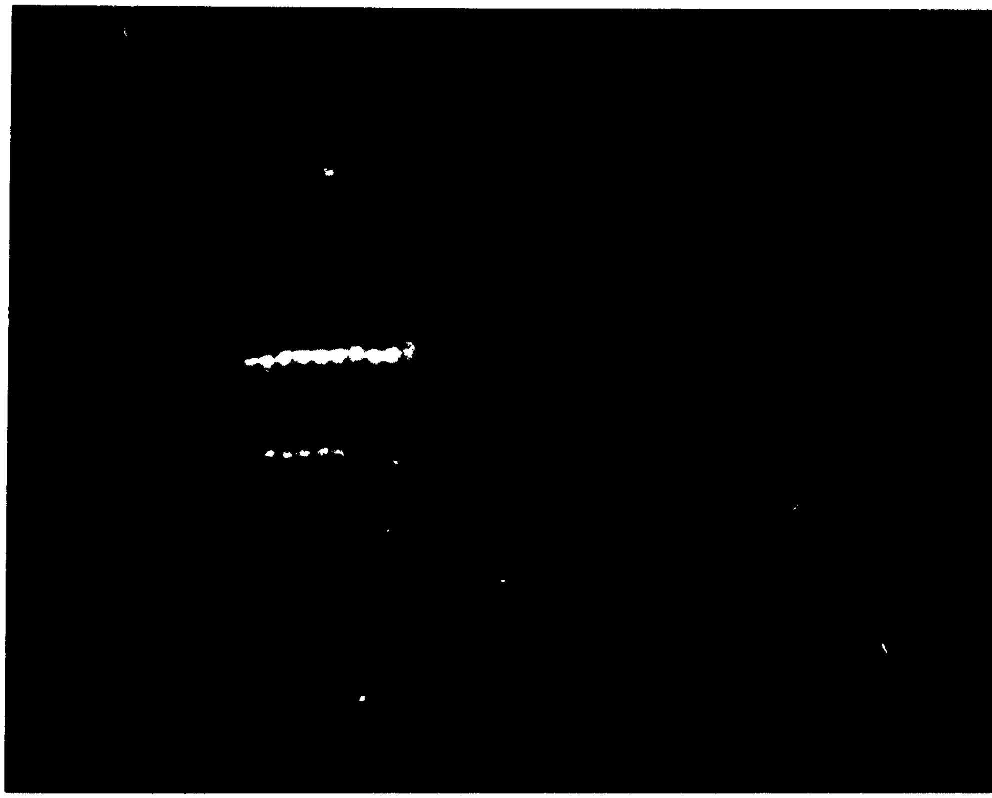
Multi Reed Valve Initial Test
Run No. 678
Trimount Pick-up No. 272-N
100 psi range
Cyclic Speed 900 cpm
Ram Air Press. 20 psi

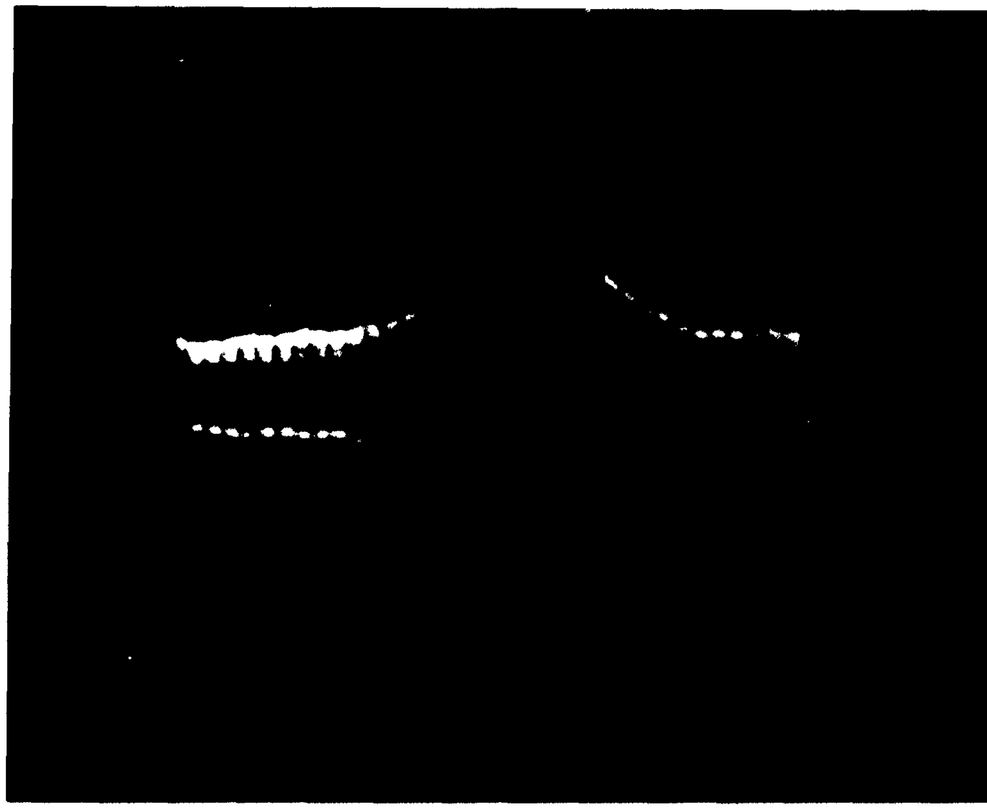


Multi Reed Valve Initial Test
Run No. 679
Trimount Pick-up No. 272-N
100 psi range
Cyclic Speed 900 cpm
Ram Air Press. 20 psi



Multi Reed Valve Initial Test
Run No. 680
Trimount Pick-up No. 272-N
100 psi range

Cyclic Speed 900 cpm
Ram Air Press. 20 psi



Multi Reed Valve Initial Test
Run No. 681
Trimount Pick-up No. 272-N
100 psi range

Cyclic Speed	900 cpm
Ram Air Press.	20 psi

Photo (a)
Multi Reed Valve Initial Test
Cyclic Speed 507
Trimount Dynamic Pressure Pick-up
No. 272-N
100 psi range

Photo (b)
Multi Reed Valve Initial Test
Cyclic Speed 1089
Trimount Dynamic Pressure Pick-up
No. 272-N
100 psi range